Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 1 of 66 Sheets

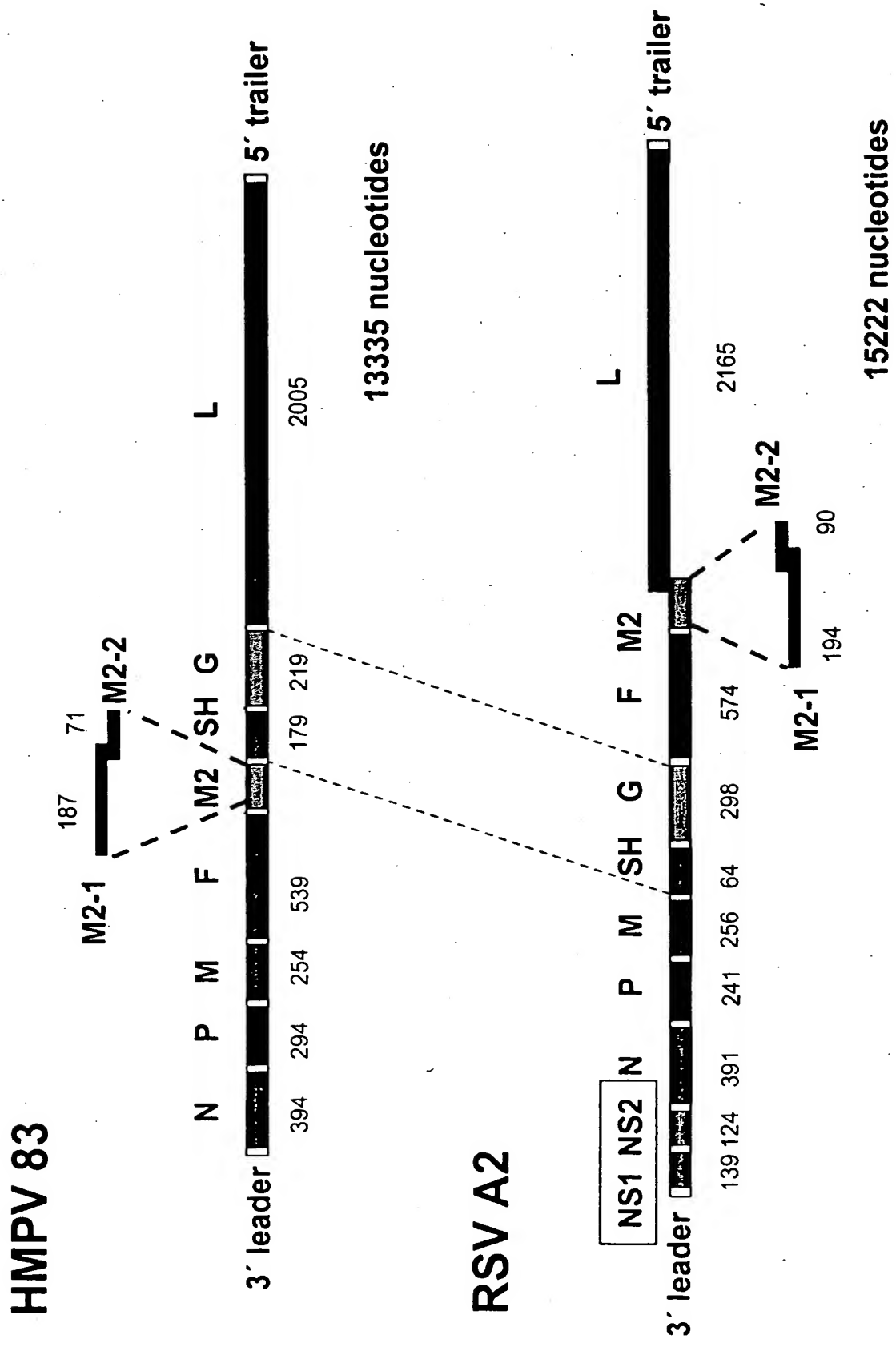

Fig. 1

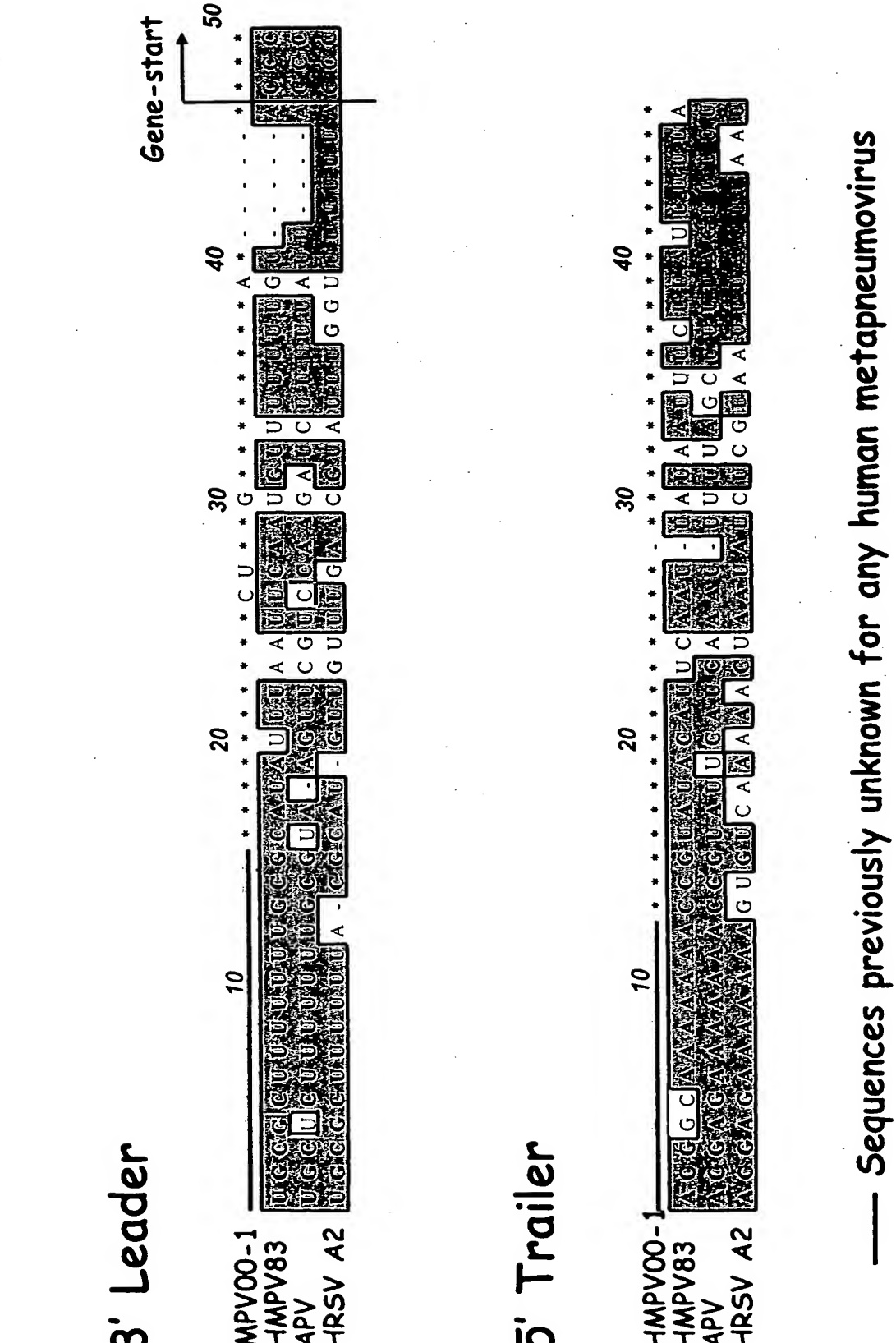
3' Leader
Gene-start
10
20
30
40
50
HMPV00-1
HMPV83
APV
HRSV A2
5' Trailer
HMPV00-1
HMPV83
APV
HRSV A2
—— Sequences previously unknown for any human metapneumovirus

Fig. 2

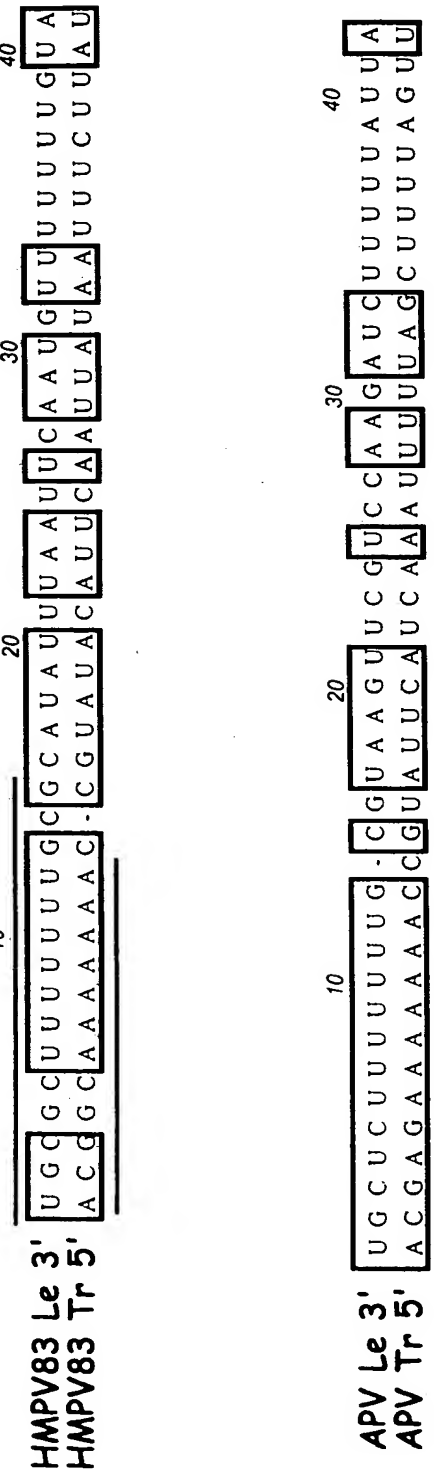

Fig. 3

Examples of differences between HMPV 83 and HMPV 00-1

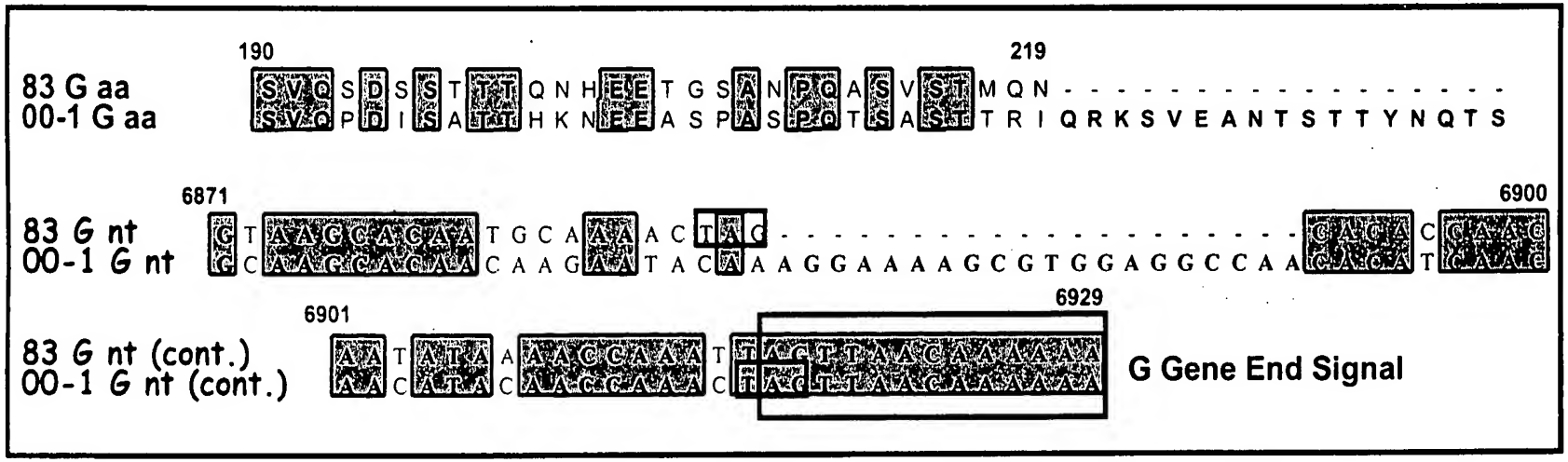

Fig. 4

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Amino acid identity between HMPV83 and other Pneumoviruses for the indicated proteins

	N	P	M	F	M 2-1	M 2-2	G	SH	L
HMPV 00-1	99	95	99	98	98	96	70	85	99
HMPV 97-82	95	85	97	94	ND	ND	ND	ND	ND
APV A	70	58	77	68	73	25	12	20	64
APV B	69	53	76	67	71	27	ND	20	ND
APV C	88	68	87	81	83	56	ND	ND	ND
HRSV A2	41	31	38	36	36	12	15	6	46
HRSV B	41	31	37	35	35	8	15	6	46
BRSV	41	31	37	37	35	14	19	10	46
PVM	45	28	38	40	36	12	ND	8	ND

ND: Comparison not done, usually because sequence was unavailable

Fig. 5

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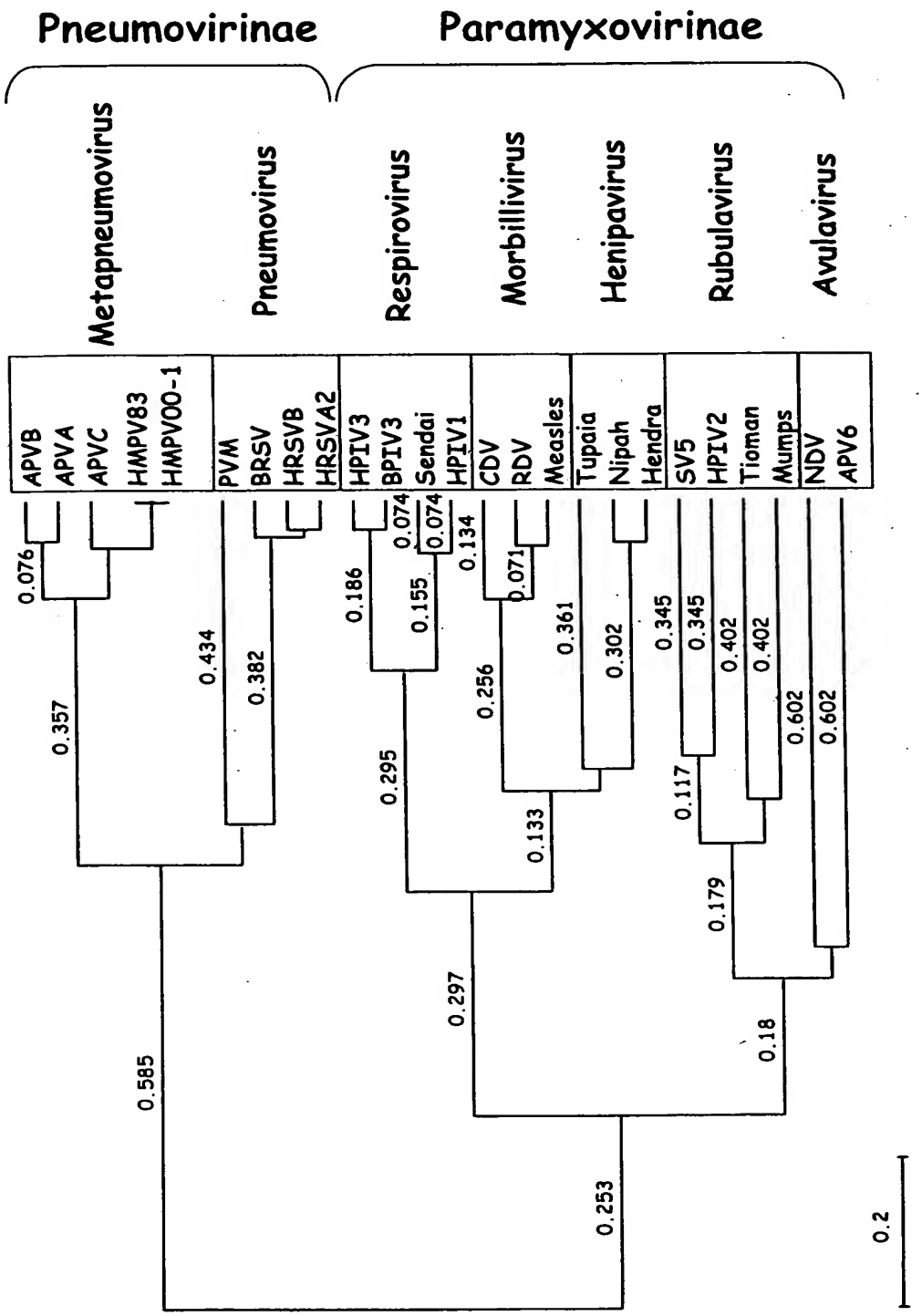
Pneumovirinae
Paramyxovirinae
Metapneumovirus
Pneumovirus
Respirovirus
Morbillivirus
Henipavirus
Rubulavirus
Avulavirus
APVB
APVA
APVC
HMPV83
HMPV00-1
PVM
BRSV
HRSVB
HRSVA2
HPIV3
BPIV3
Sendai
HPIV1
CDV
RDV
Measles
Tupaia
Nipah
Hendra
SV5
HPIV2
Tioman
Mumps
NDV
APV6
0.076
0.357
0.434
0.382
0.585
0.186
0.074
0.074
0.155
0.134
0.295
0.256
0.071
0.361
0.302
0.133
0.345
0.345
0.402
0.402
0.117
0.602
0.602
0.179
0.297
0.18
0.253
0.2

Fig. 6

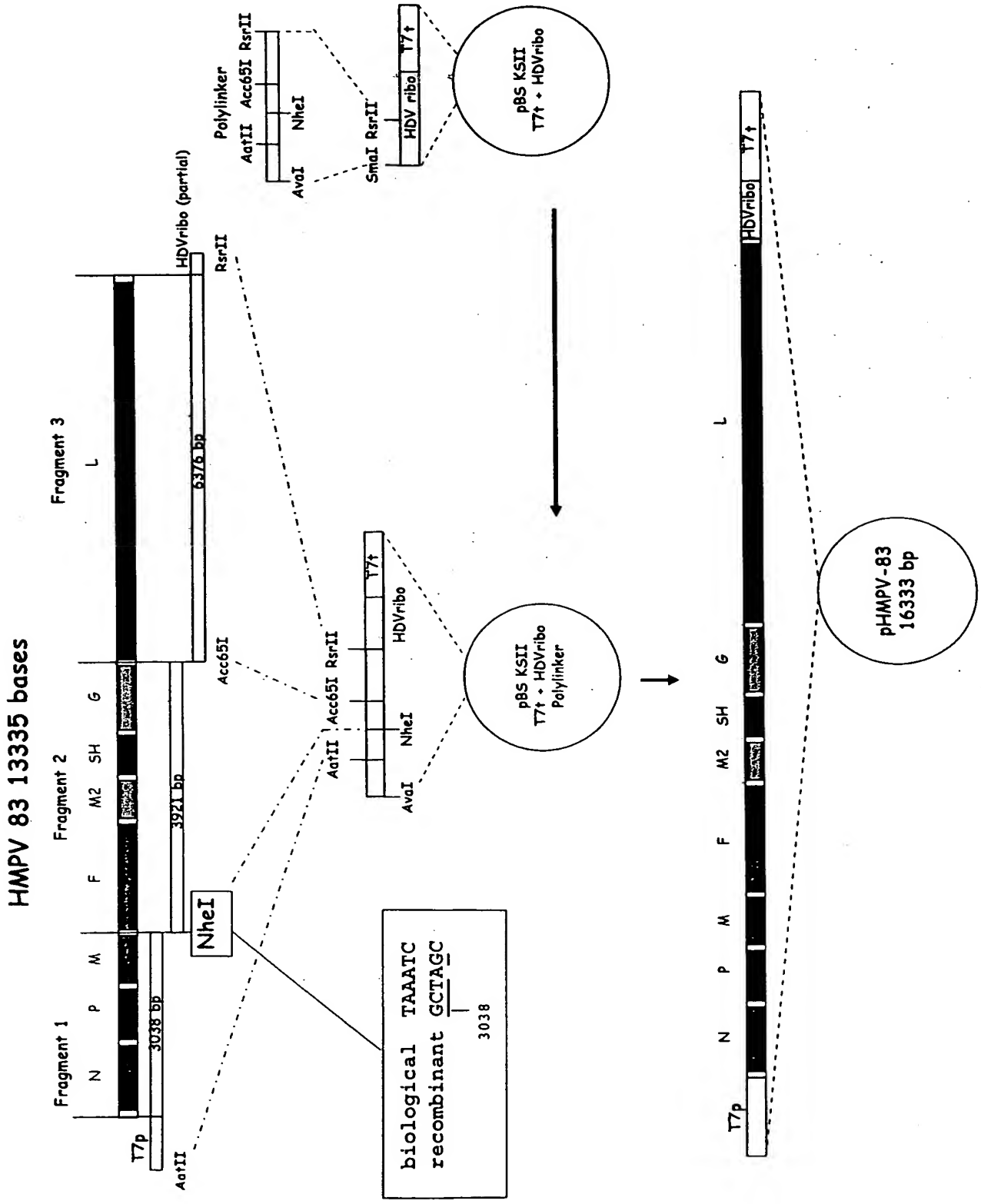
HMPV 83 13335 bases
Fragment 1
Fragment 2
Fragment 3
N
P
M
F
M2
SH
G
L
T7p
3038 bp
3921 bp
6376 bp
HDVribo (partial)
RsrII
Acc65I
AatII
NheI
biological recombinant
TAAATC
GCTAGC
3038
Polylinker
AatII Acc65I RsrII
NheI
AvaI
SmaI RsrII
HDV ribo
T7t
pBS KSII
T7t + HDVribo
pBS KSII
T7t + HDVribo
Polylinker
HDVribo
pHMPV-83
16333 bp

Fig. 7

Gene Start Signal

```
                          1   5    10    15
N         tacaaaaaaacat GGGACAAGTGAAA ATGtctcttc
P         taattaaaaaagt GGGACAAGTCAAA ATGtcattcc
M         aaaaataaaaat GGGACAAGTGAAA ATGgagtcct
F         atcaatcaagaac GGGACAAATAAAA ATGtcttgga
M2        taaaataaaattt GGGACAAATCATA ATGtctcgca
SH        aacacatcagagt GGGATAAGTGACA ATGataacat
G         aaaacaaaaatat GGGACAAGTAGTT ATGgaggtga
L         aaacagcatccaa GAGACAAATAGCA ATGgatcctc

CONSENSUS          ...at GGGACAAGTGAAA ATGtc...
                      gc  A  T  A AGTT    ga
                      ta          C C     at
```

Gene End Signal

```
                        1   5    10
N               ttatg AGTAATTAAAAAA gt
P               tatgt AGTTTAATAAAAA taaaaaat
M               atttt AGTTATATAAAAA tcaagttagaat a
F               cagtt AGTTAATTAAAAA taaaataaaatt t
M2              actta AGTTAGTAAAAA  cacatcagagt
SH              agttt AGTTATTTTAAAA tatttgagaata g
G               aaatt AGTTAACAAAAAA tacgagatagct c
L               atgat AGTTAATTAAAA  ttaaaaattaaaa a

CONSENSUS          ...tt AGTTAATTAAAAA ta...
                      ag    ATTAAT   . cc
                      ga      GC       gt
```

Fig. 8

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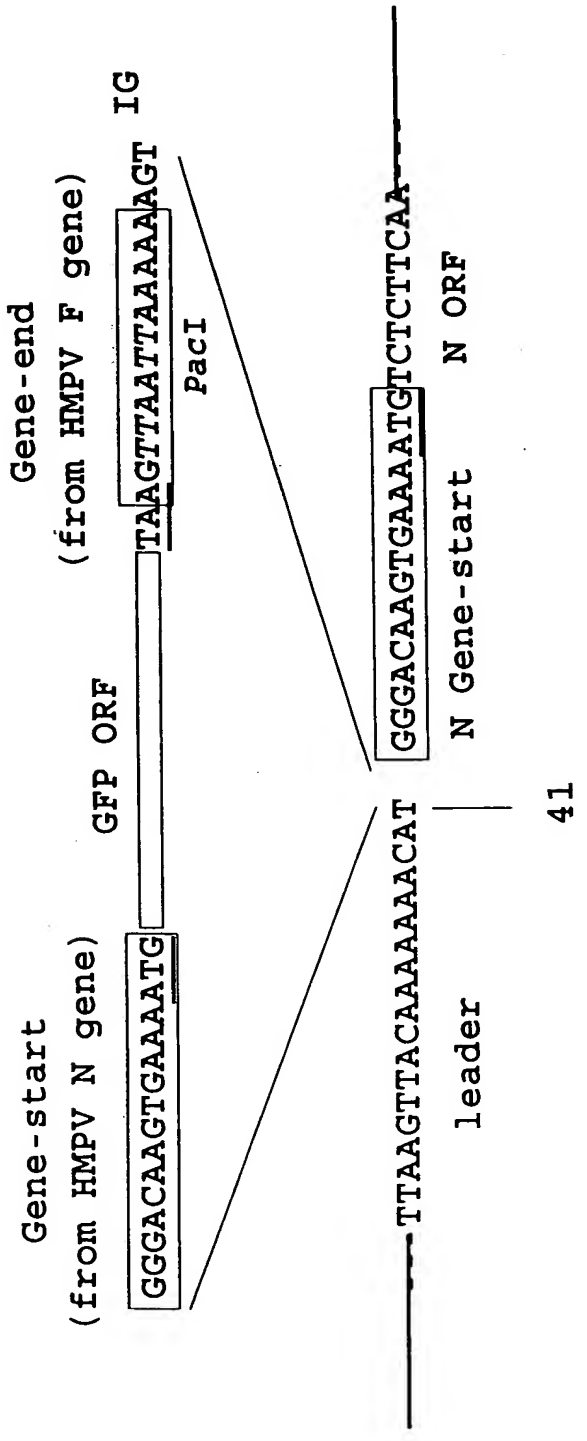
Gene-start
(from HMPV N gene)
GGGACAAGTGAAAATG
GFP ORF
Gene-end
(from HMPV F gene)
TAAGTTAATTAAAAAAGT
IG
PacI
TTAAGTTACAAAAAACAT
leader
41
GGGACAAGTGAAAATGTCTCTTCAA
N Gene-start
N ORF

Fig. 9

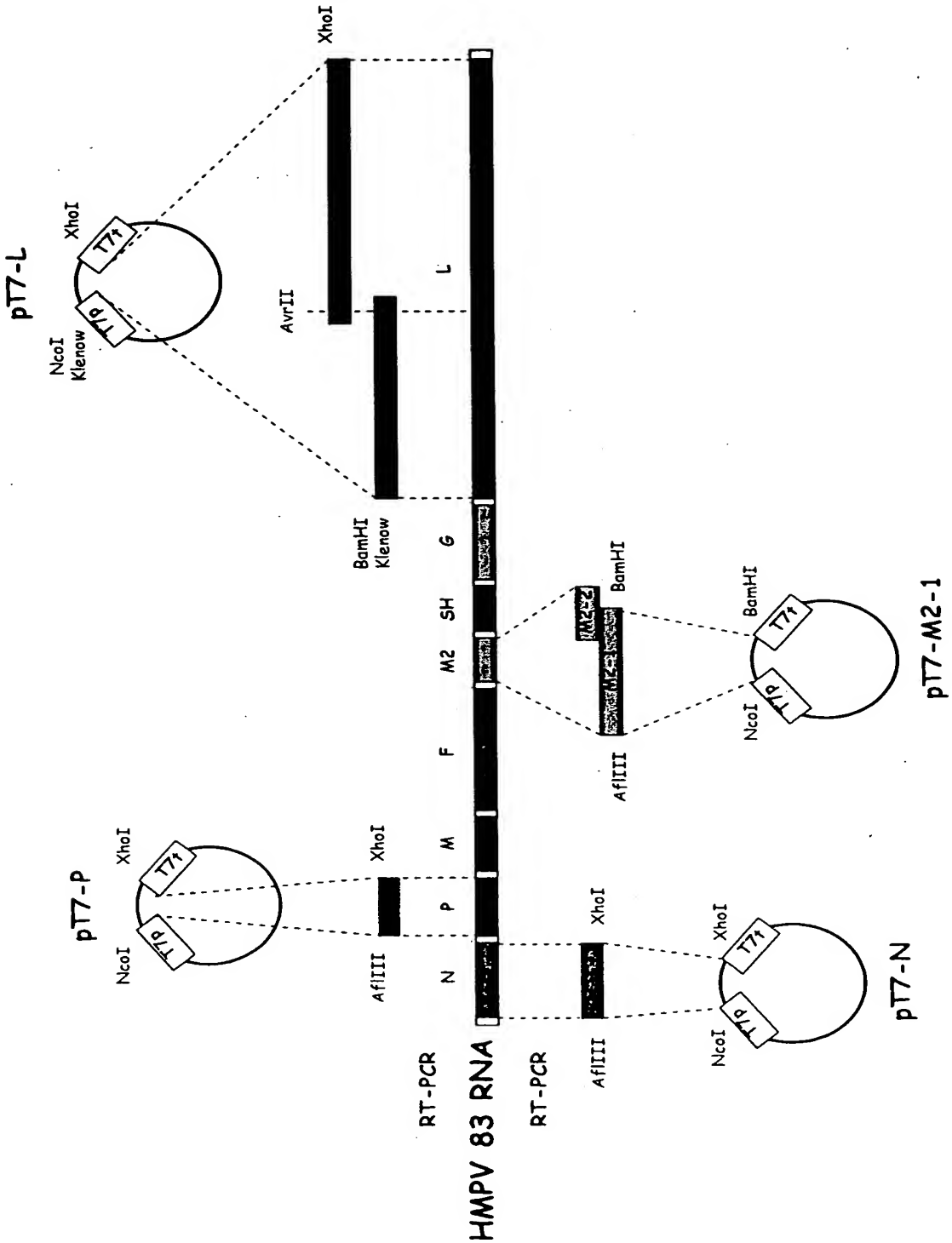
pT7-L
XhoI
T7
δ/τ
NcoI
Klenow
AvrII
L
BamHI
Klenow
G
SH
M2
F
M
P
N
RT-PCR
HMPV 83 RNA
RT-PCR
AflIII
pT7-M2-1
BamHI
pT7-P
pT7-N

Fig. 10

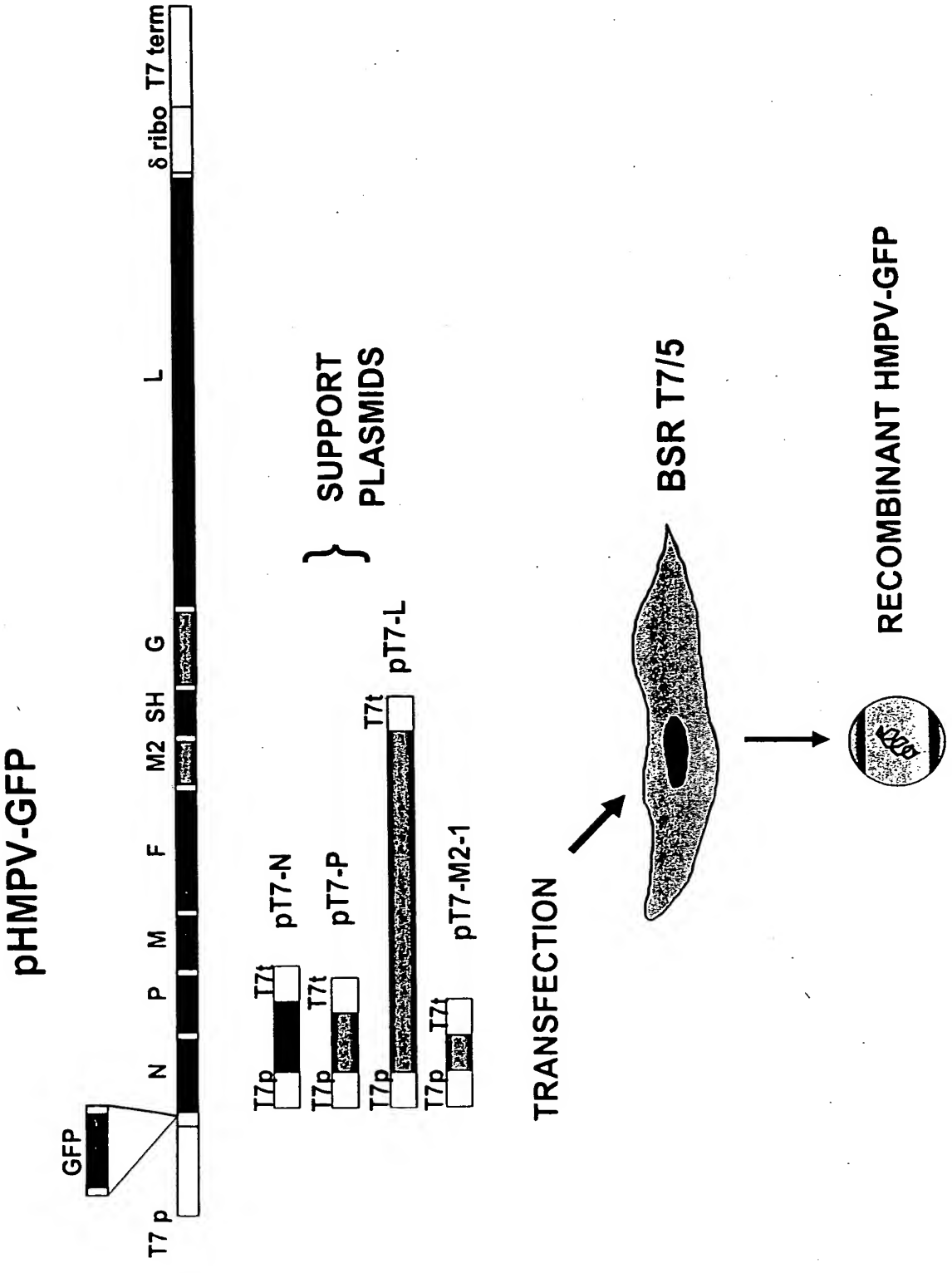
pHMPV-GFP
T7 p
GFP
N
P
M
F
M2
SH
G
L
δ ribo
T7 term
T7p
T7t
pT7-N
pT7-P
pT7-L
pT7-M2-1
SUPPORT PLASMIDS
TRANSFECTION
BSR T7/5
RECOMBINANT HMPV-GFP

Fig. 11

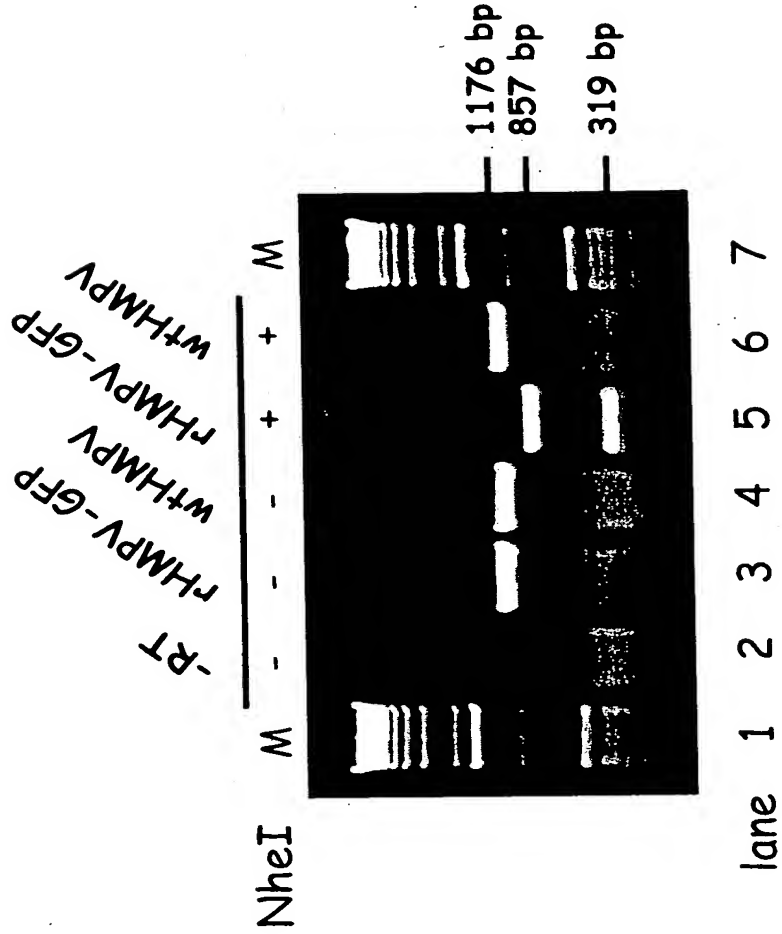
1176 bp
857 bp
319 bp
NheI
M
-RT
rHMPV-GFP
wtHMPV
rHMPV-GFP
wtHMPV
M
lane 1 2 3 4 5 6 7

Fig. 12A

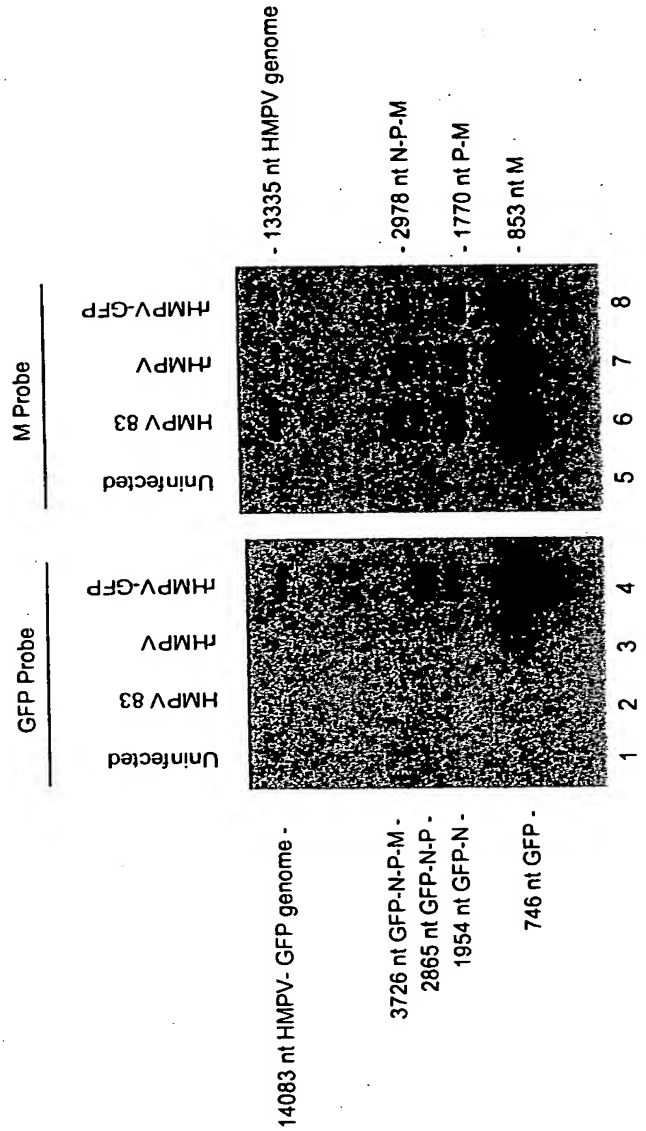
GFP Probe
M Probe
Uninfected
HMPV 83
rHMPV
rHMPV-GFP
1 2 3 4 5 6 7 8
14083 nt HMPV- GFP genome -
3726 nt GFP-N-P-M -
2865 nt GFP-N-P -
1954 nt GFP-N -
746 nt GFP -
13335 nt HMPV genome
2978 nt N-P-M
1770 nt P-M
853 nt M

Fig. 12B

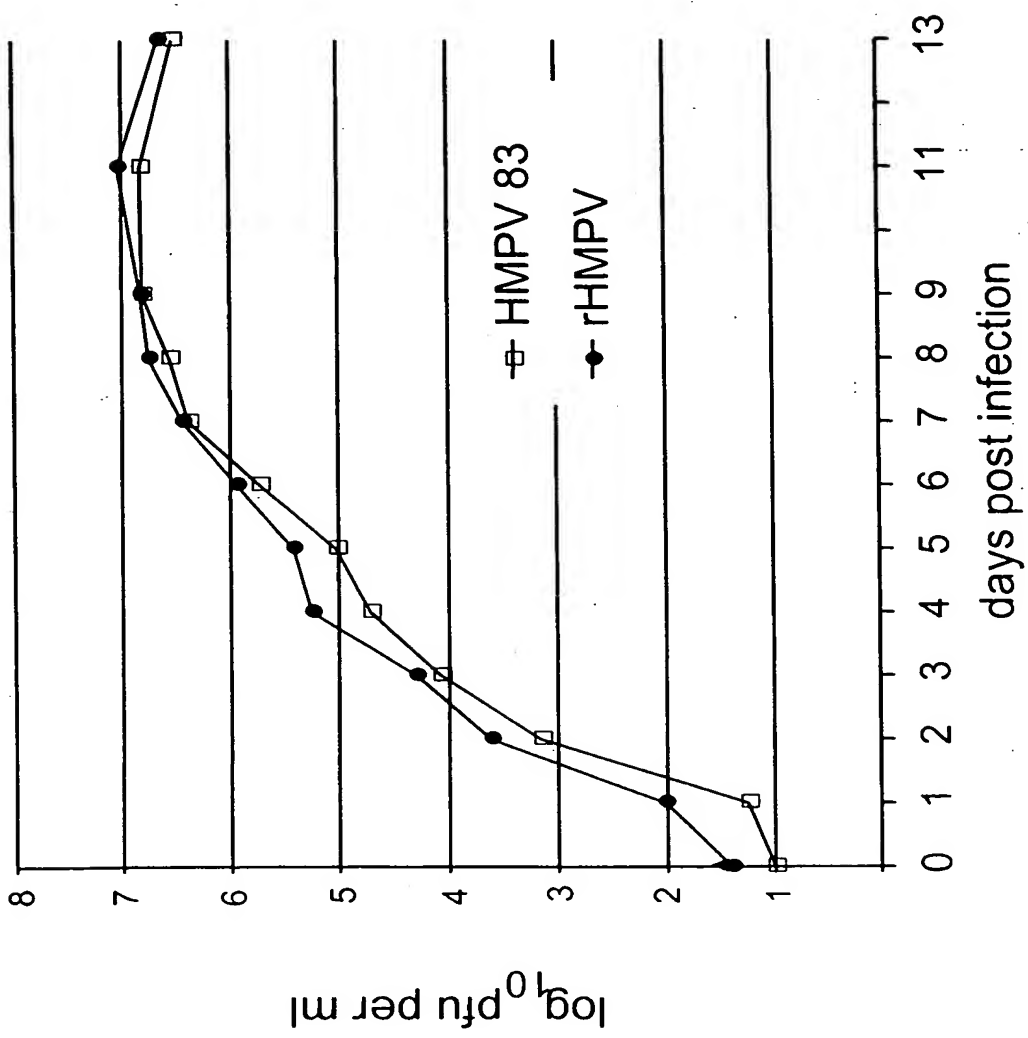
log10pfu per ml
8
7
6
5
4
3
2
1
0 1 2 3 4 5 6 7 8 9 11 13
days post infection
HMPV 83
rHMPV

Fig. 13

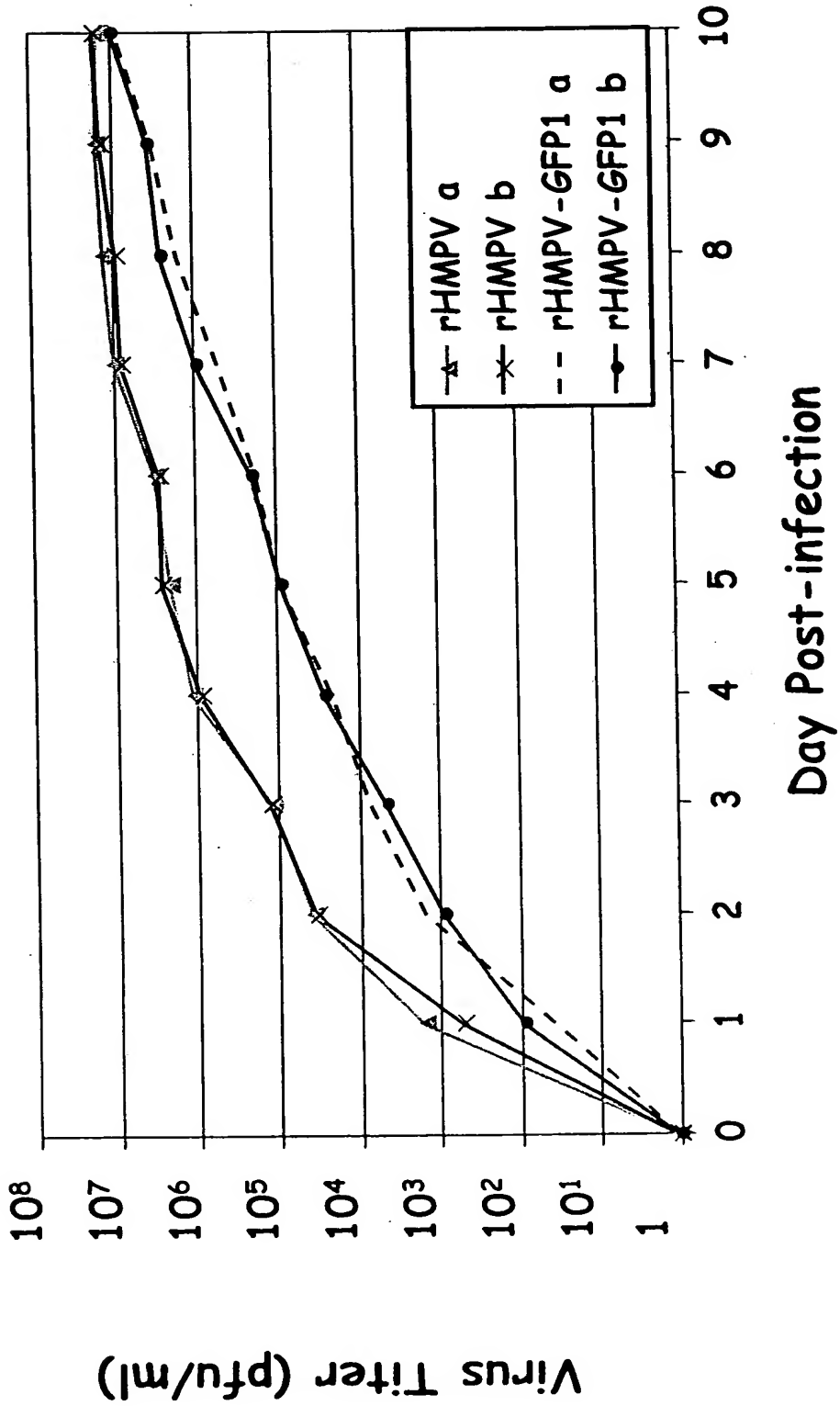
Virus Titer (pfu/ml)
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10^1
1
0
1
2
3
4
5
6
7
8
9
10
Day Post-infection
rHMPV a
rHMPV b
rHMPV-GFP1 a
rHMPV-GFP1 b

Fig. 14

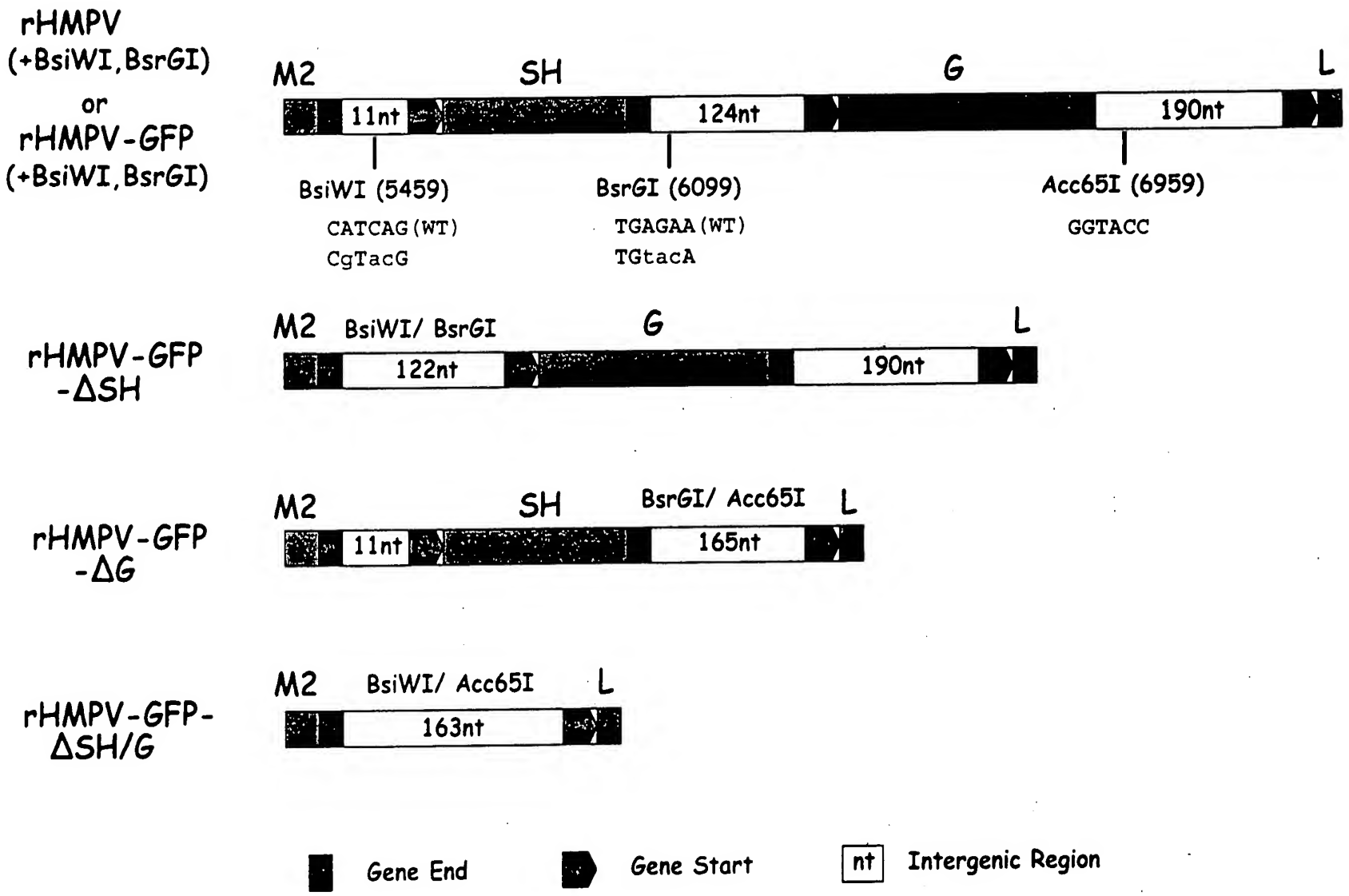

Fig. 15

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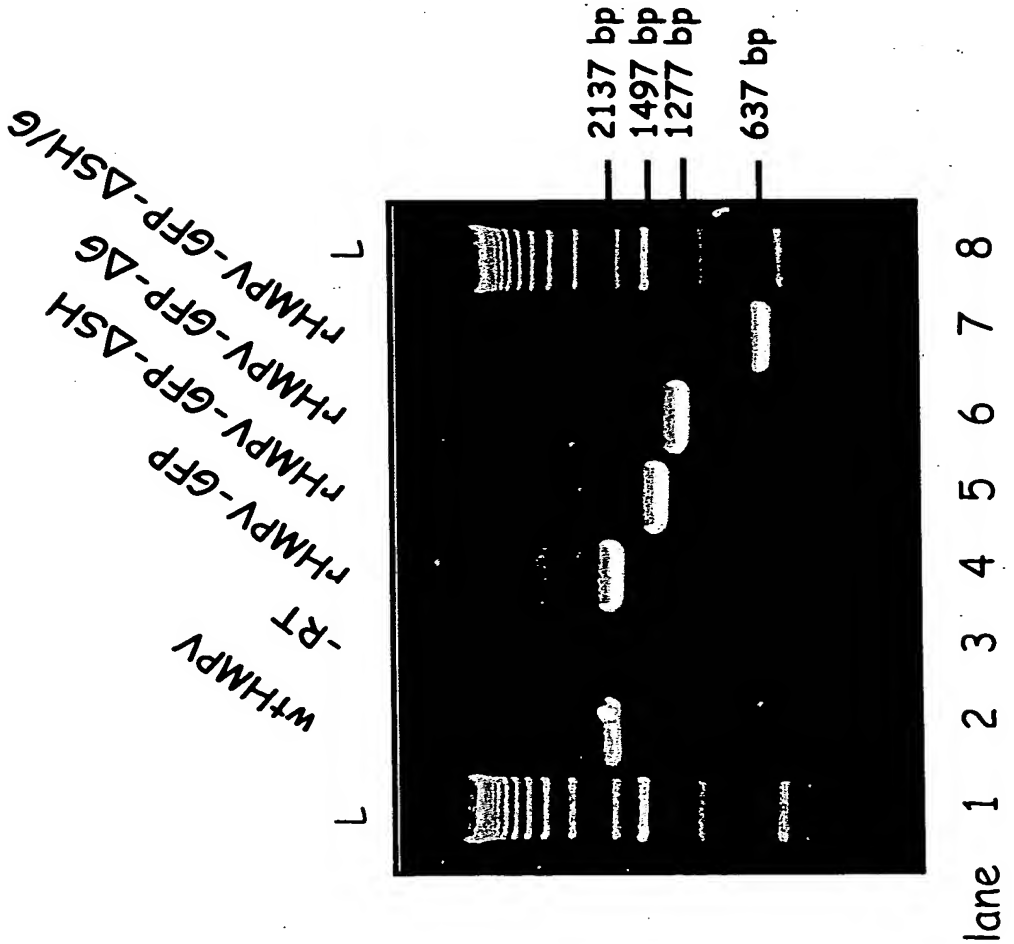
2137 bp
1497 bp
1277 bp
637 bp
L
wtHMPV
-RT
rHMPV-GFP
rHMPV-GFP-ΔSH
rHMPV-GFP-ΔG
rHMPV-GFP-ΔSH/G
L
lane 1 2 3 4 5 6 7 8

Fig. 16

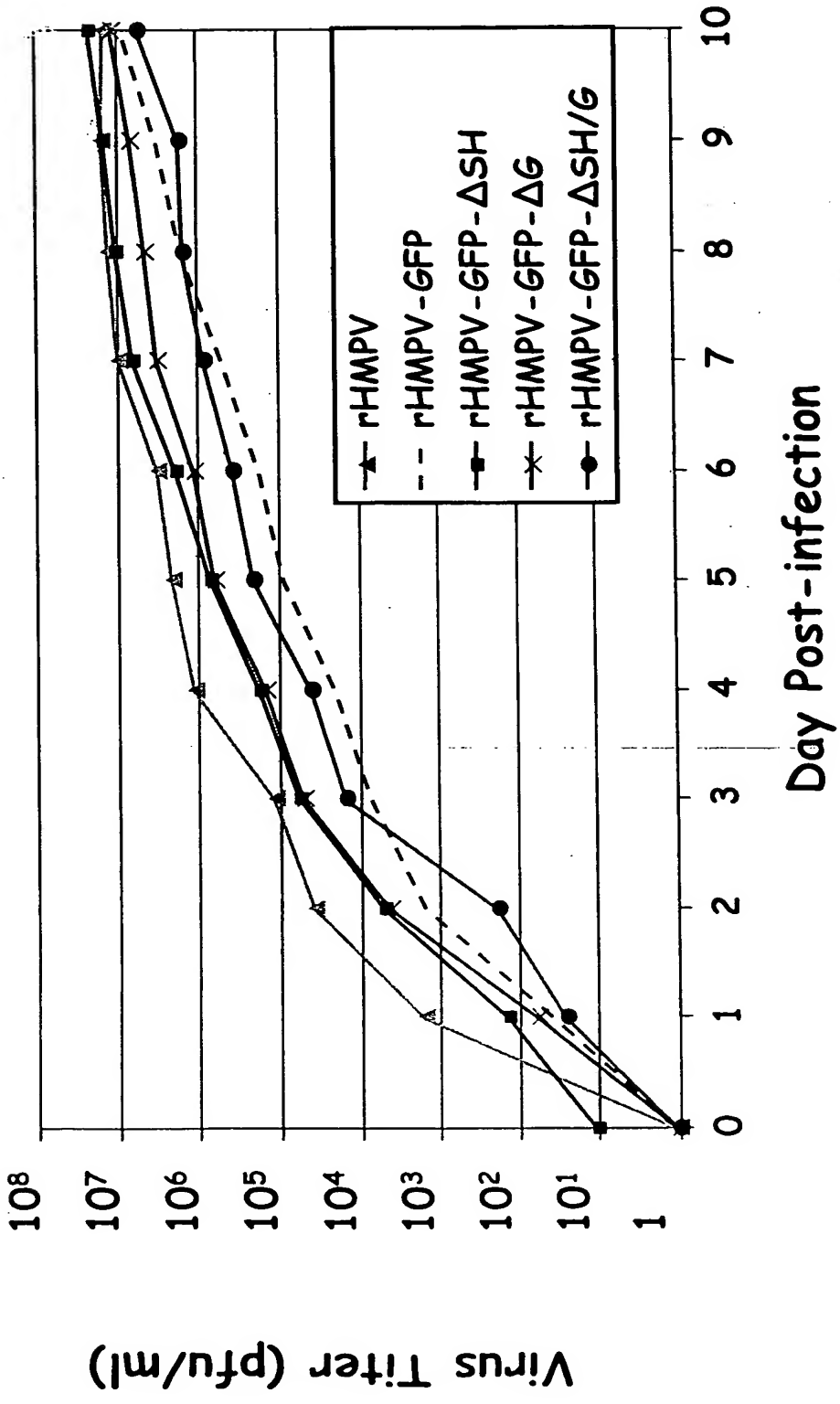
Virus Titer (pfu/ml)
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10^1
1
0
1
2
3
4
5
6
7
8
9
10
Day Post-infection
rHMPV
rHMPV-GFP
rHMPV-GFP-ΔSH
rHMPV-GFP-ΔG
rHMPV-GFP-ΔSH/G

Fig. 17A

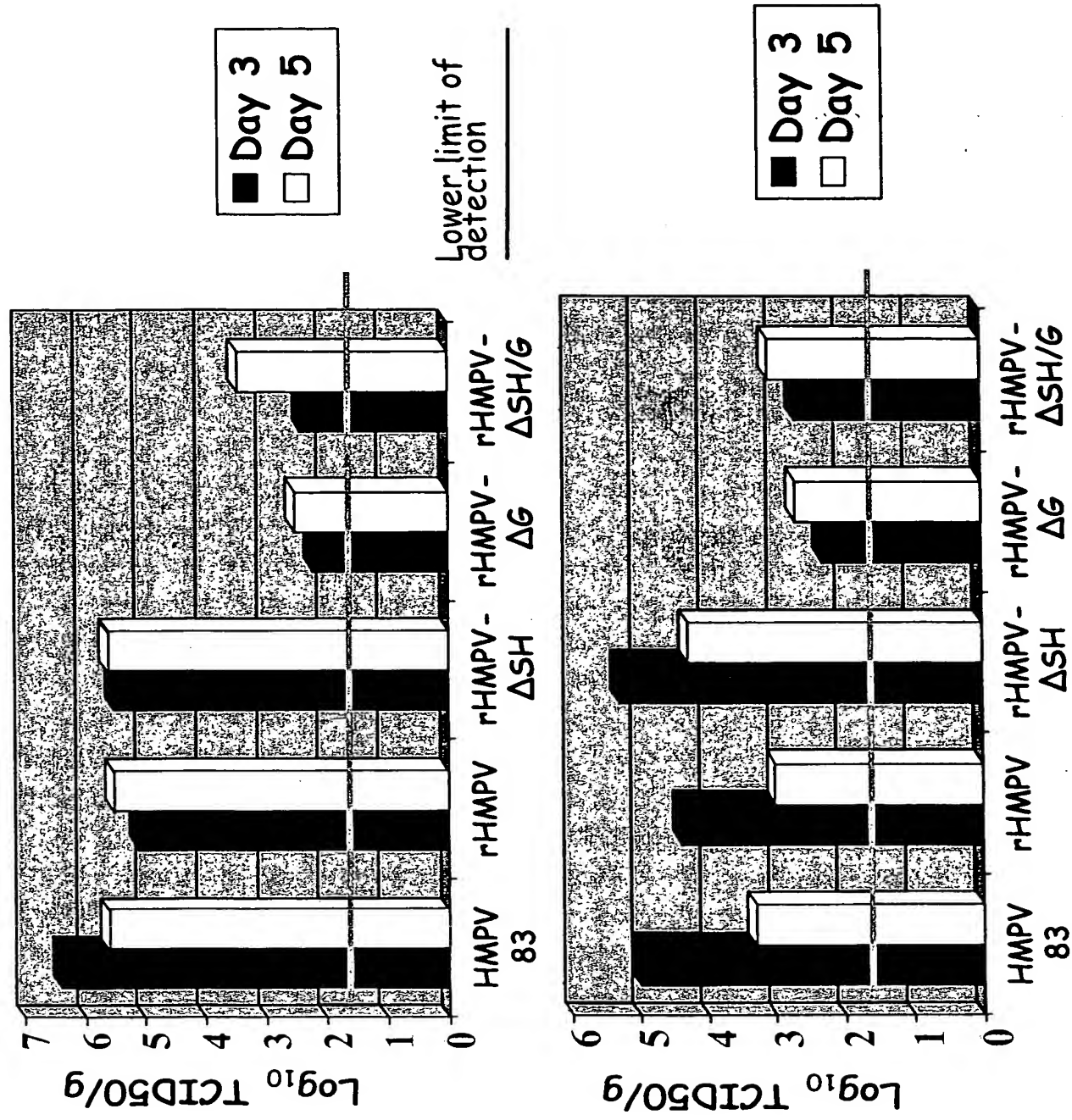
Nasal Turbinates
Lungs
Log10 TCID50/g
Day 3
Day 5
Lower limit of detection
HMPV
rHMPV
rHMPV-ΔSH
rHMPV-ΔG
rHMPV-ΔSH/G
83

Fig. 17B

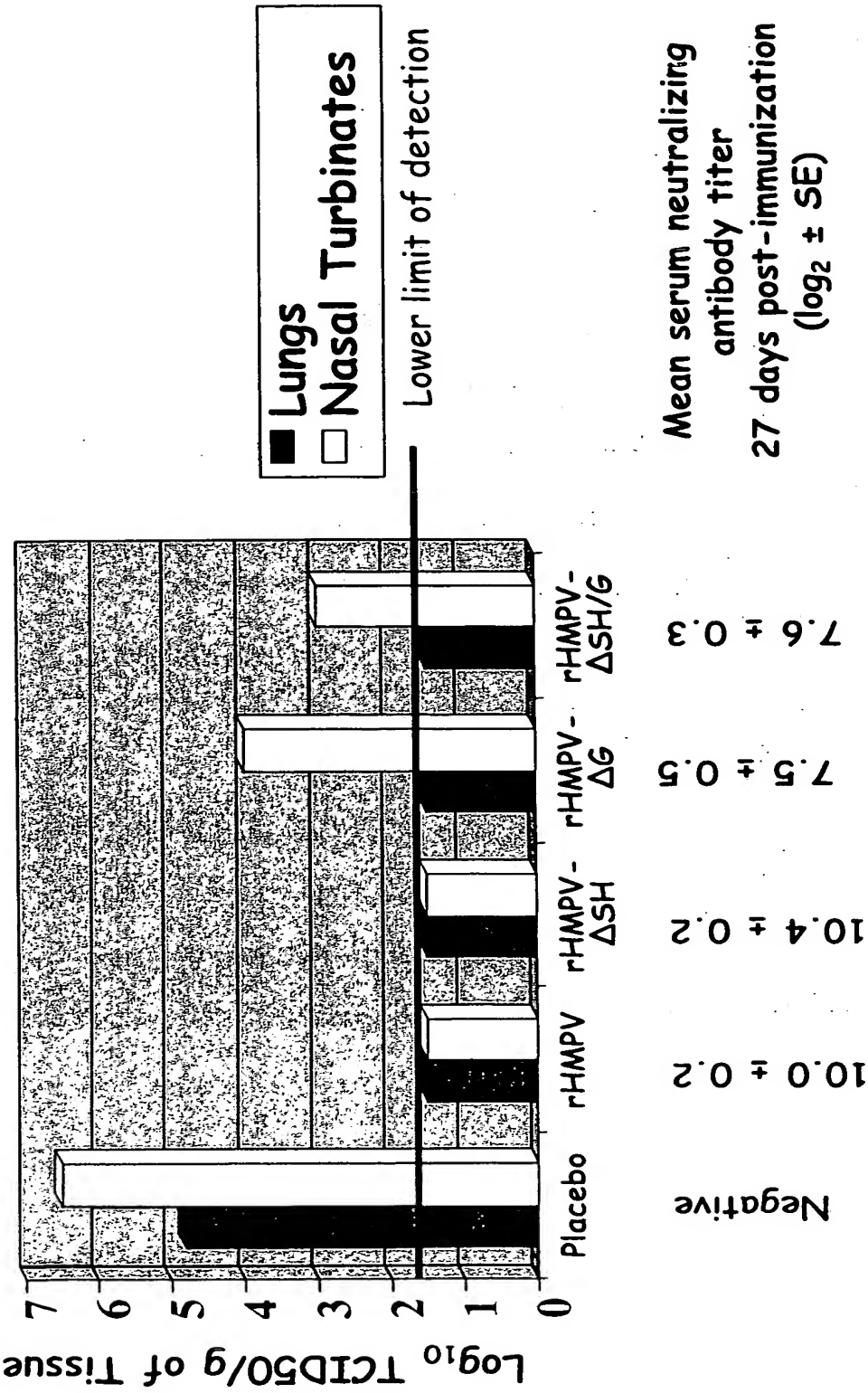
Log10 TCID50/g of Tissue
7
6
5
4
3
2
1
0
Lungs
Nasal Turbinates
Lower limit of detection
Placebo
rHMPV
rHMPV-ΔSH
rHMPV-ΔG
rHMPV-ΔSH/G
Negative
10.0 ± 0.2
10.4 ± 0.2
7.5 ± 0.5
7.6 ± 0.3
Mean serum neutralizing antibody titer 27 days post-immunization (log2 ± SE)

Fig. 17C

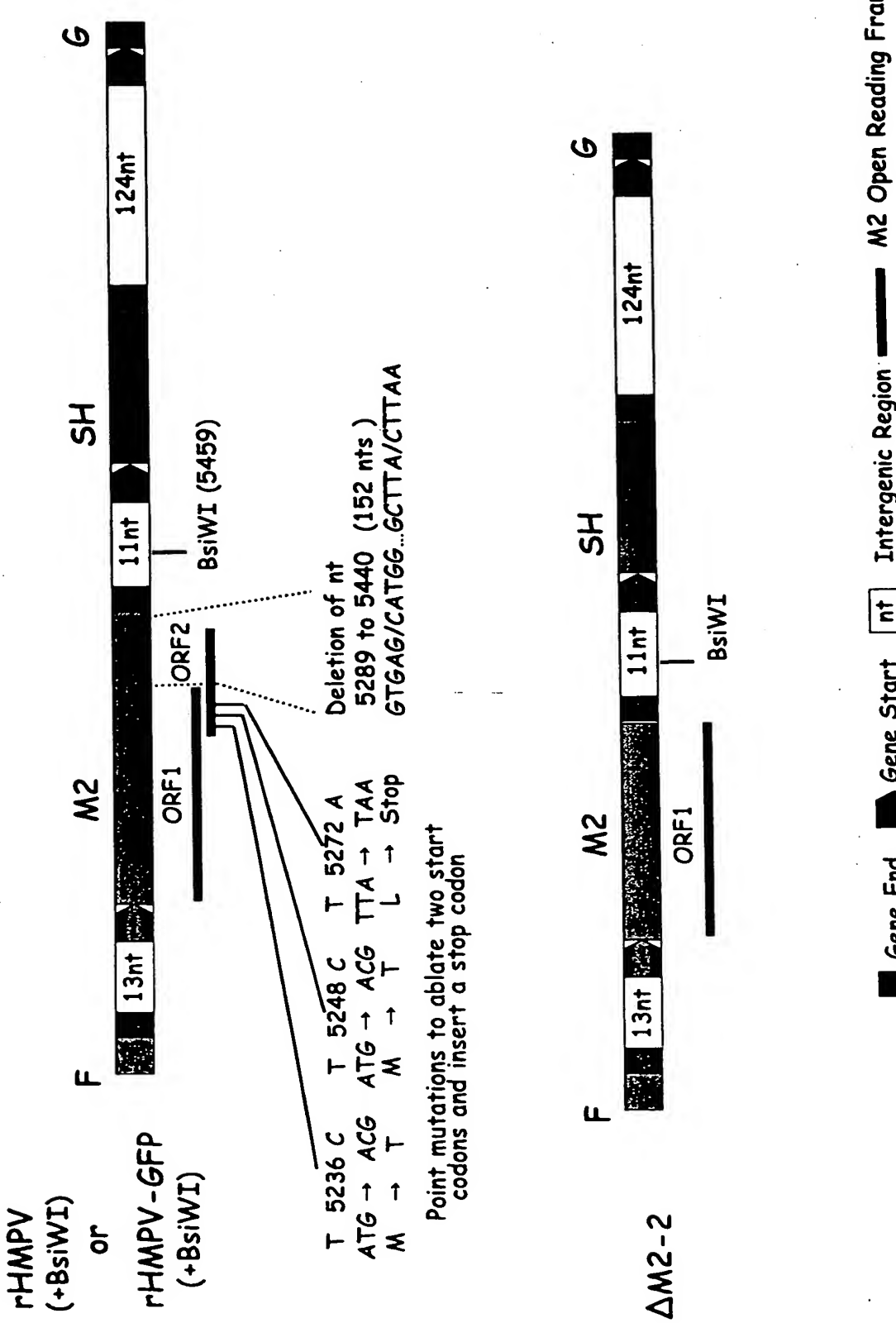
rHMPV
(+BsiWI)
or
rHMPV-GFP
(+BsiWI)
F
M2
SH
G
13nt
ORF1
ORF2
11nt
124nt
BsiWI (5459)
Deletion of nt
5289 to 5440 (152 nts)
GTGAG/CATGG...GCTTA/CTTAA
T 5236 C
ATG → ACG
M → T
T 5248 C
ATG → ACG
M → T
T 5272 A
TTA → TAA
L → Stop
Point mutations to ablate two start codons and insert a stop codon
ΔM2-2
F
M2
SH
G
13nt
ORF1
11nt
124nt
BsiWI
Gene End
Gene Start
nt
Intergenic Region
M2 Open Reading Frame

Fig. 18A

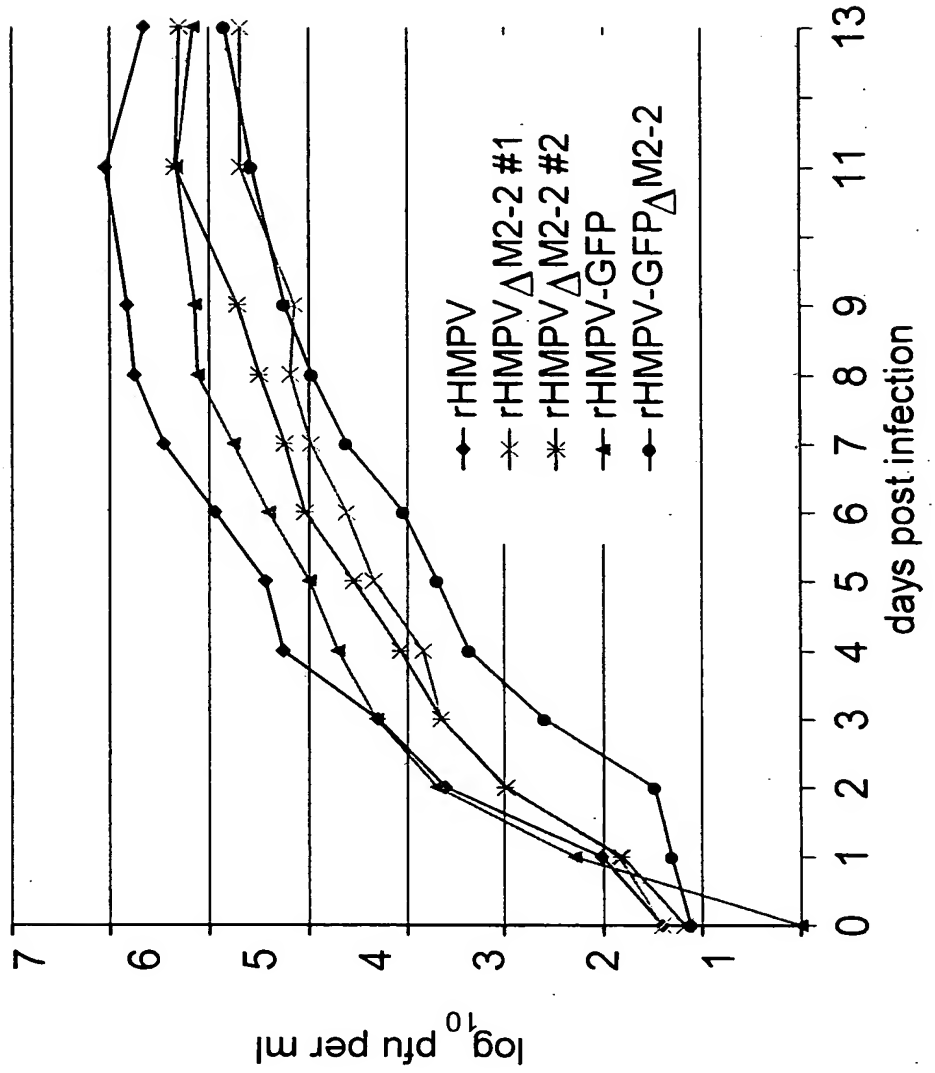
log10 pfu per ml
7
6
5
4
3
2
1
0 1 2 3 4 5 6 7 8 9 11 13
days post infection
rHMPV
rHMPVΔM2-2 #1
rHMPVΔM2-2 #2
rHMPV-GFP
rHMPV-GFPΔM2-2

Fig. 18B

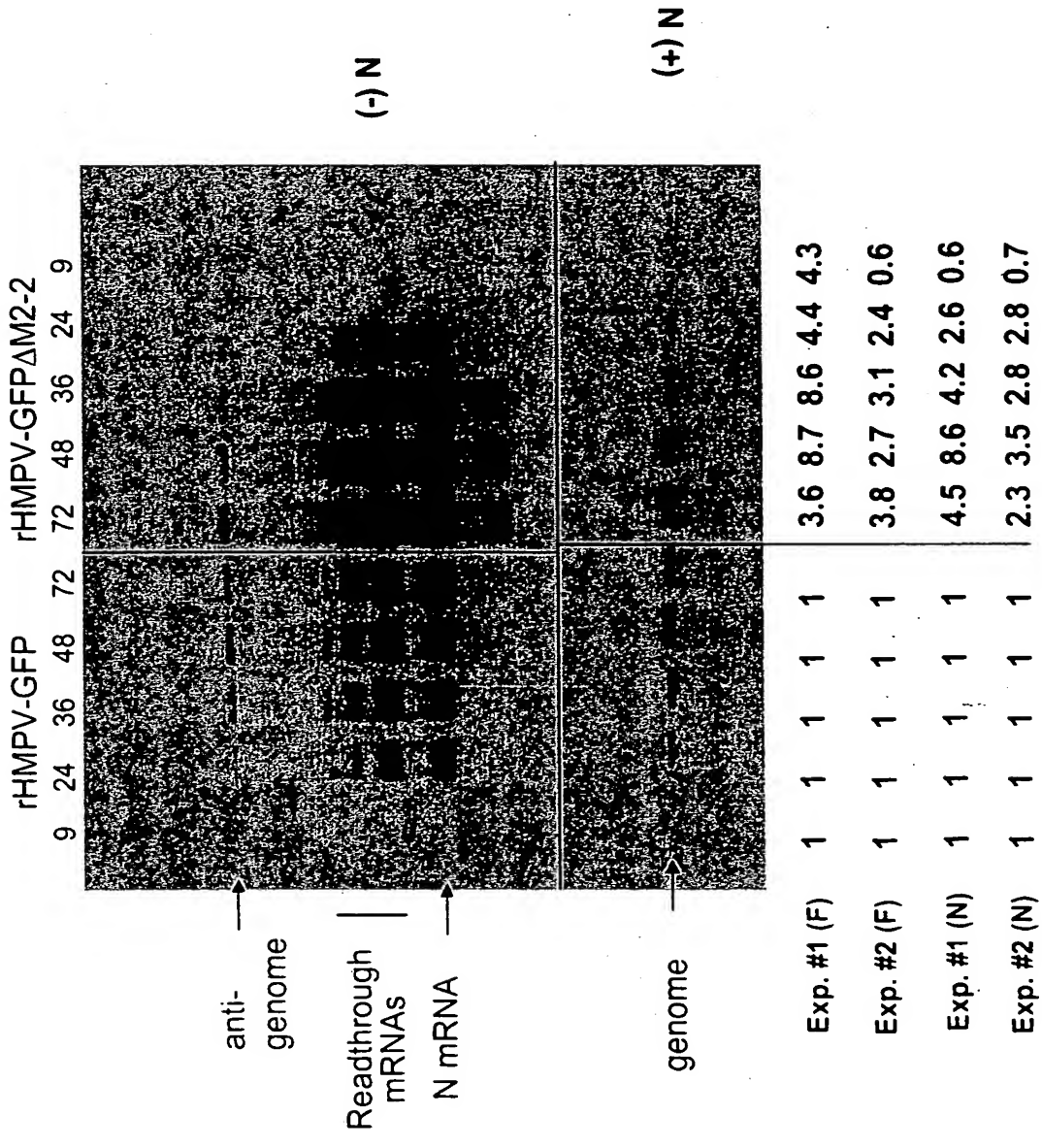
rHMPV-GFP
rHMPV-GFPΔM2-2
9 24 36 48 72
9 24 36 48 72
(-) N
(+) N
anti-genome
Readthrough mRNAs
N mRNA
genome
mRNA
Genome
Exp. #1 (F) 1 1 1 1 1 3.6 8.7 8.6 4.4 4.3
Exp. #2 (F) 1 1 1 1 1 3.8 2.7 3.1 2.4 0.6
Exp. #1 (N) 1 1 1 1 1 4.5 8.6 4.2 2.6 0.6
Exp. #2 (N) 1 1 1 1 1 2.3 3.5 2.8 2.8 0.7

Fig. 18C

							C			X7				C		X5				C		X3		H	
	M	S	R	K	A	P	C	K	Y	E	V	R	G	K	C	N	R	G	S	E	C	K	F	N	H	N
HMPV-GFP M2 C7S	M	S	R	K	A	P	**S**	K	Y	E	V	R	G	K	C	N	R	G	S	E	C	K	F	N	H	N
HMPV-GFP M2 Y9S	M	S	R	K	A	P	C	K	**S**	E	V	R	G	K	C	N	R	G	S	E	C	K	F	N	H	N
HMPV-GFP M2 C15S	M	S	R	K	A	P	C	K	Y	E	V	R	G	K	**S**	N	R	G	S	E	C	K	F	N	H	N
HMPV-GFP M2 N16S	M	S	R	K	A	P	C	K	Y	E	V	R	G	K	C	**S**	R	G	S	E	C	K	F	N	H	N
HMPV-GFP M2 H25S	M	S	R	K	A	P	C	K	Y	E	V	R	G	K	C	N	R	G	S	E	C	K	F	N	**S**	N

Fig. 19

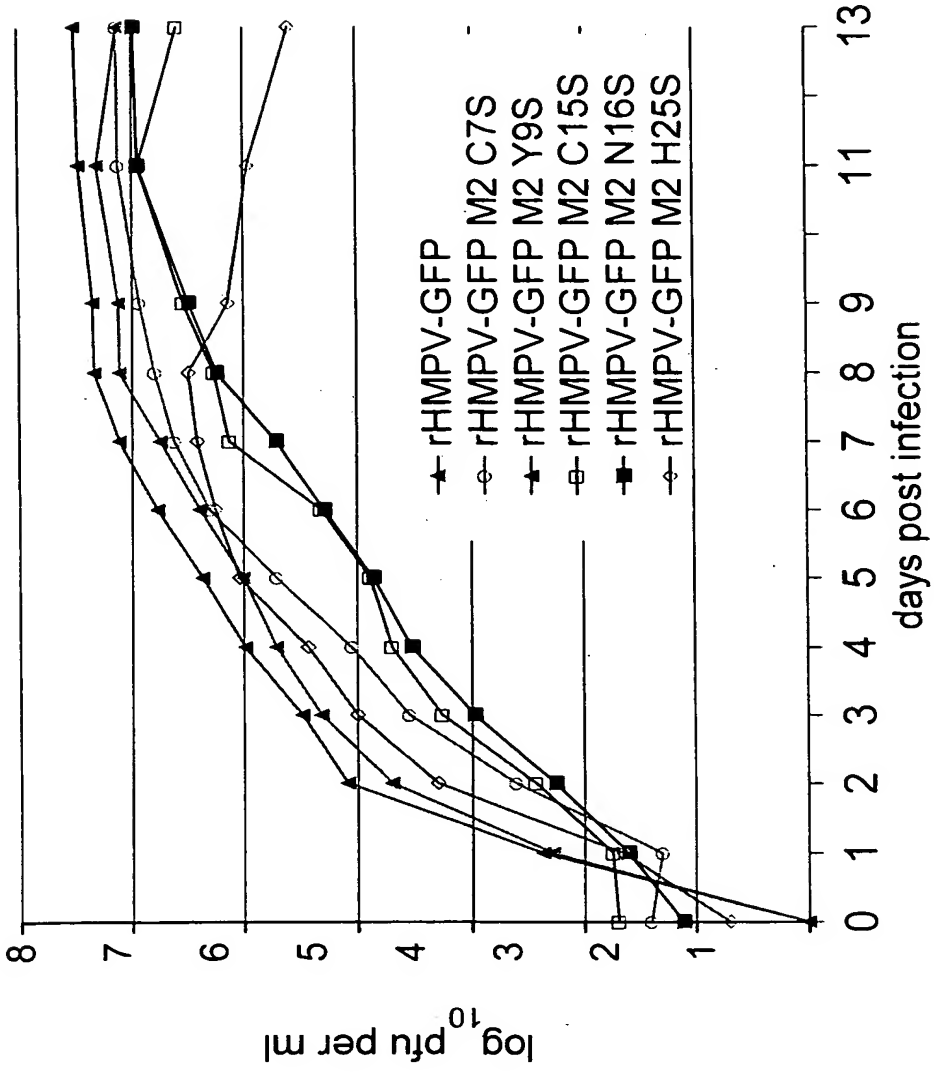
log10 pfu per ml
8
7
6
5
4
3
2
1
0 1 2 3 4 5 6 7 8 9 11 13
days post infection
rHMPV-GFP
rHMPV-GFP M2 C7S
rHMPV-GFP M2 Y9S
rHMPV-GFP M2 C15S
rHMPV-GFP M2 N16S
rHMPV-GFP M2 H25S

Fig. 20

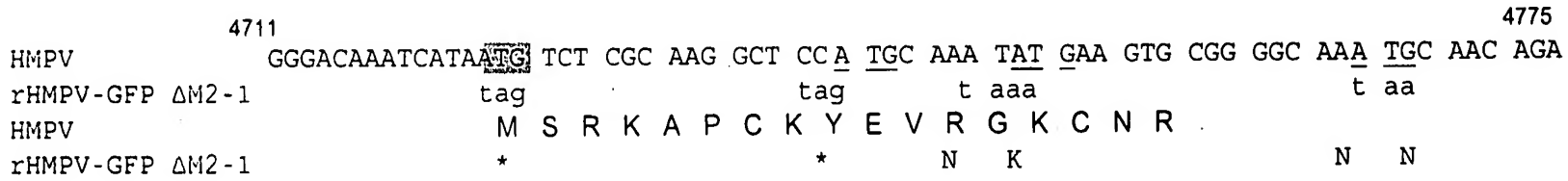

Fig. 21

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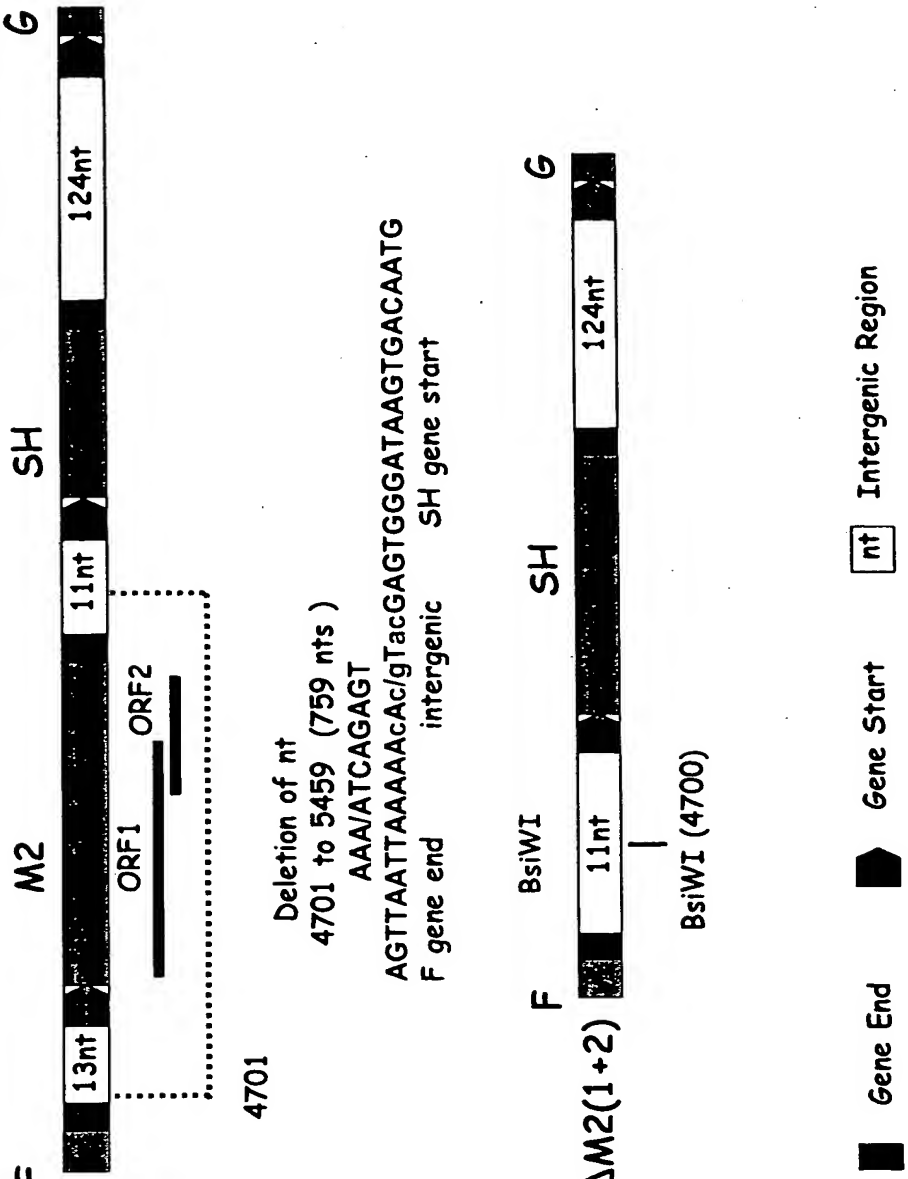
rHMPV-GFP (+BsiWI)
F
M2
SH
G
13nt
ORF1
ORF2
11nt
124nt
4701
Deletion of nt
4701 to 5459 (759 nts)
AAA/ATCAGAGT
AGTTAATTAAAAAcAc/gTacGAGTGGGATAAGTGACAATG
F gene end
intergenic
SH gene start
rHMPV-GFP ΔM2(1+2)
F
BsiWI
SH
G
11nt
124nt
BsiWI (4700)
Gene End
Gene Start
nt
Intergenic Region

Fig. 22A

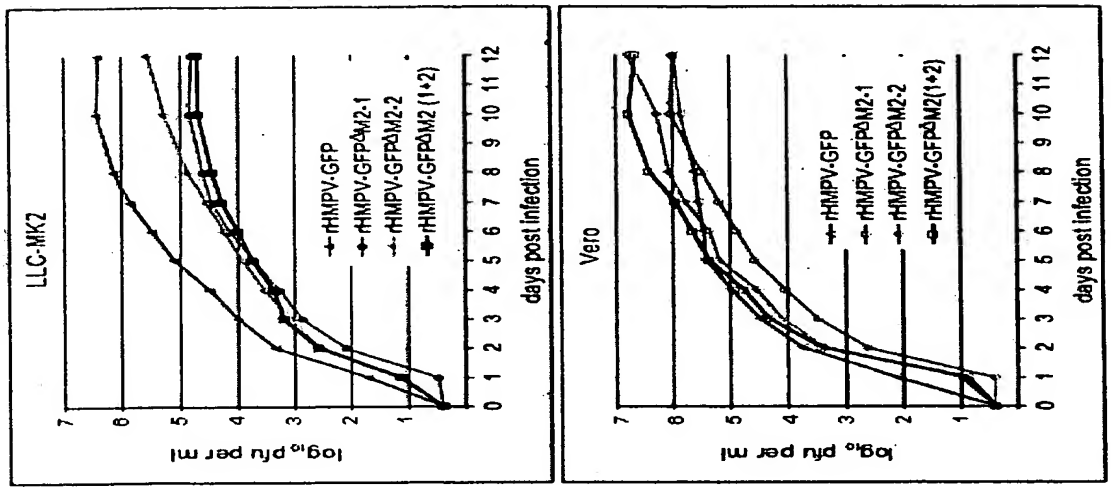
LLC-MK2
Vero
log10 pfu per ml
days post infection
rHMPV-GFP
rHMPV-GFPΔM2-1
rHMPV-GFPΔM2-2
rHMPV-GFPΔM2(1+2)

Fig. 2B

Reduction of virus yield in presence of exogenous interferon (IFN) type I

		Fold reduction of virus yield		
Virus	MOI	10 U IFN	100 U IFN	1000 U IFN
rHMPV-GFP	1.0	5	160	1680
rHMPV-GFP$_{\Delta}$M2(1+2)	1.0	19	1130	no virus
rHMPV-GFP$_{\Delta}$M2-2	1.0	13	250	no virus
RSV-GFP	0.01	4	17	90

Fig. 22C

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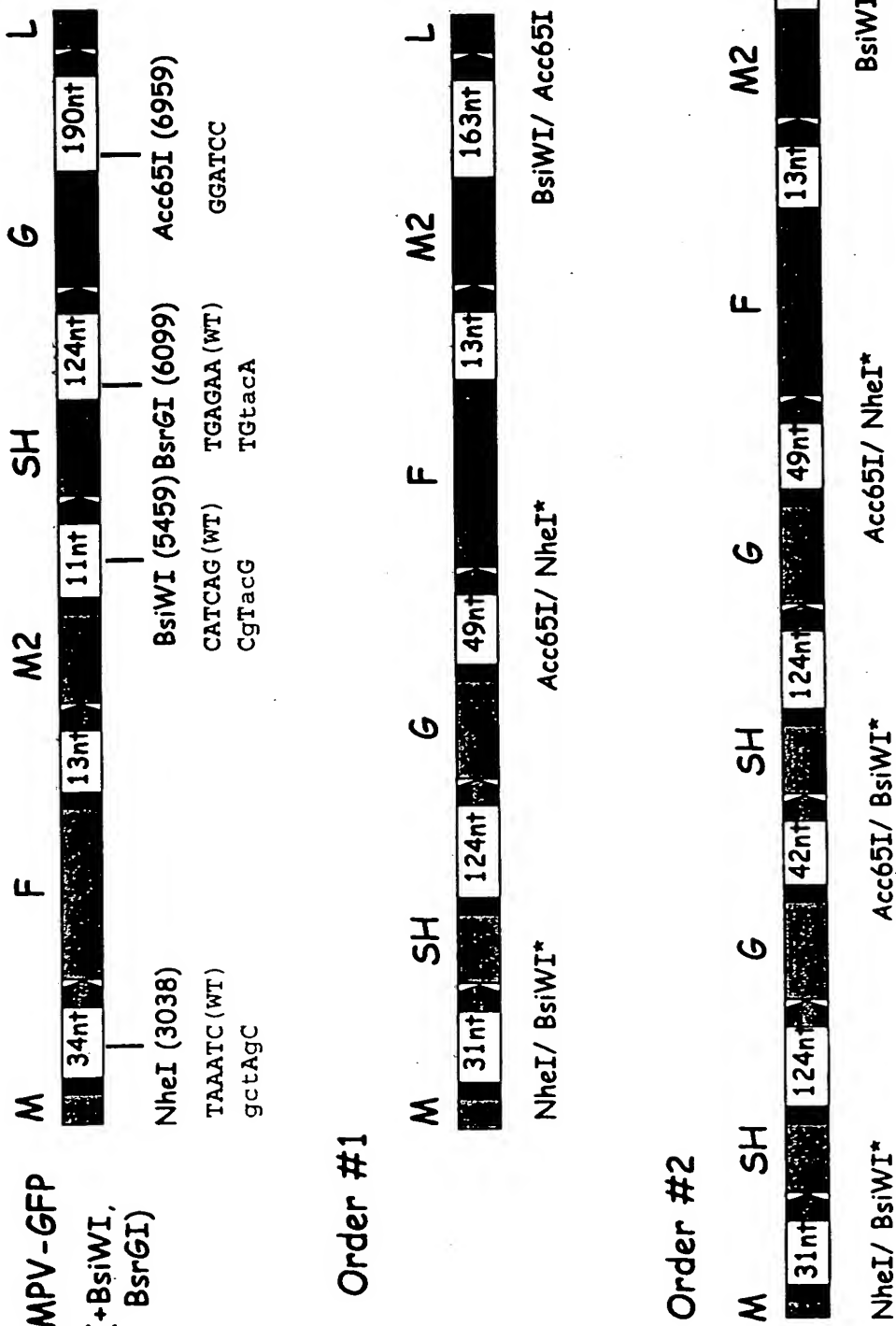

rHMPV-GFP (+BsiWI, BsrGI)
M
F
M2
SH
G
L
34nt
13nt
11nt
124nt
190nt
NheI (3038)
TAAATC (WT)
gctAgC
BsiWI (5459)
CATCAG (WT)
CgTacG
BsrGI (6099)
TGAGAA (WT)
TGtacA
Acc65I (6959)
GGATCC
Order #1
31nt
124nt
49nt
13nt
163nt
NheI/ BsiWI*
Acc65I/ NheI*
BsiWI/ Acc65I
Order #2
124nt
42nt
124nt
49nt
13nt
163nt
Acc65I/ BsiWI*
Gene End
Gene Start
nt
Intergenic Region

Fig. 23A

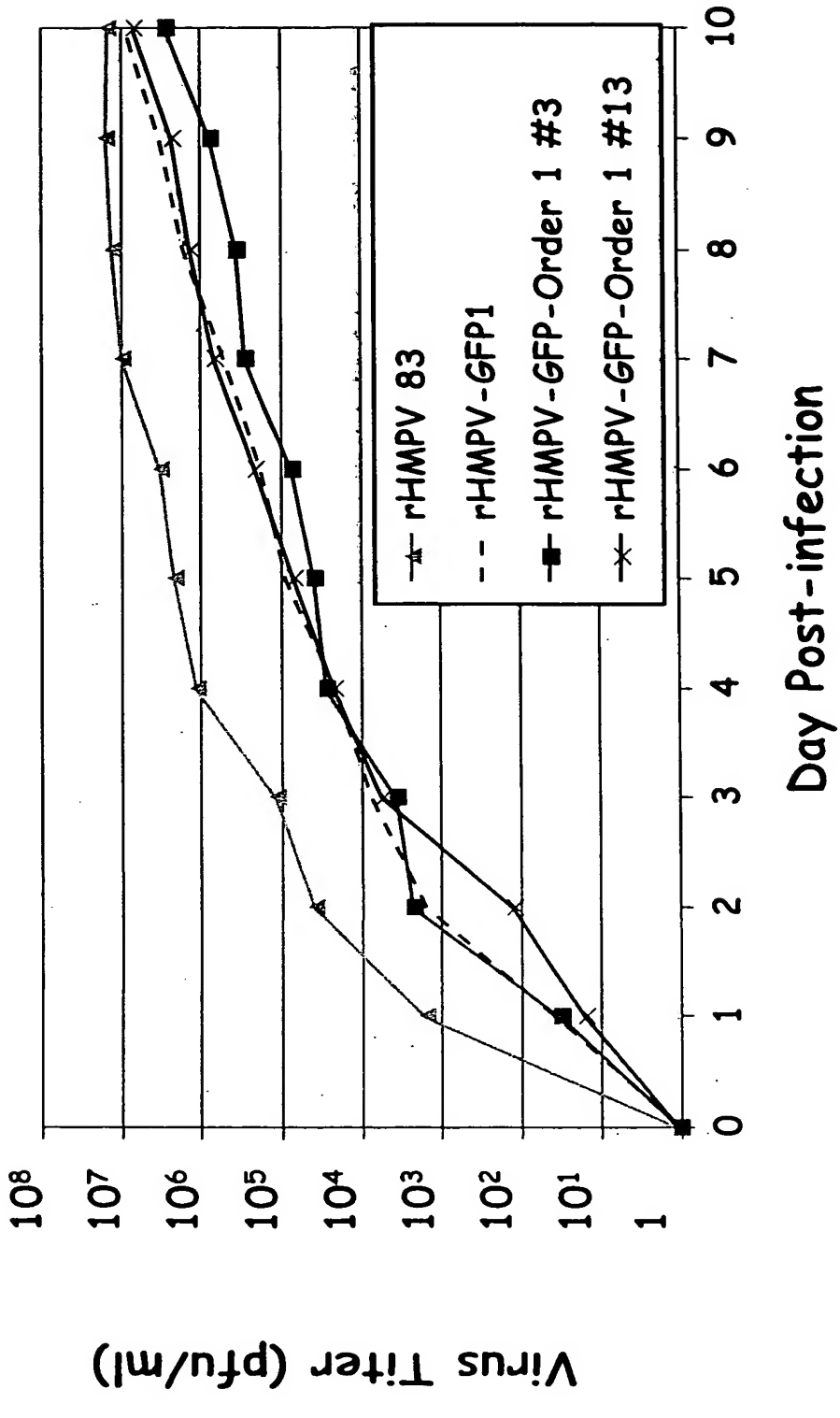

Virus Titer (pfu/ml)
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10^1
1
0
1
2
3
4
5
6
7
8
9
10
Day Post-infection
rHMPV 83
rHMPV-GFP1
rHMPV-GFP-Order 1 #3
rHMPV-GFP-Order 1 #13

Fig. 23B

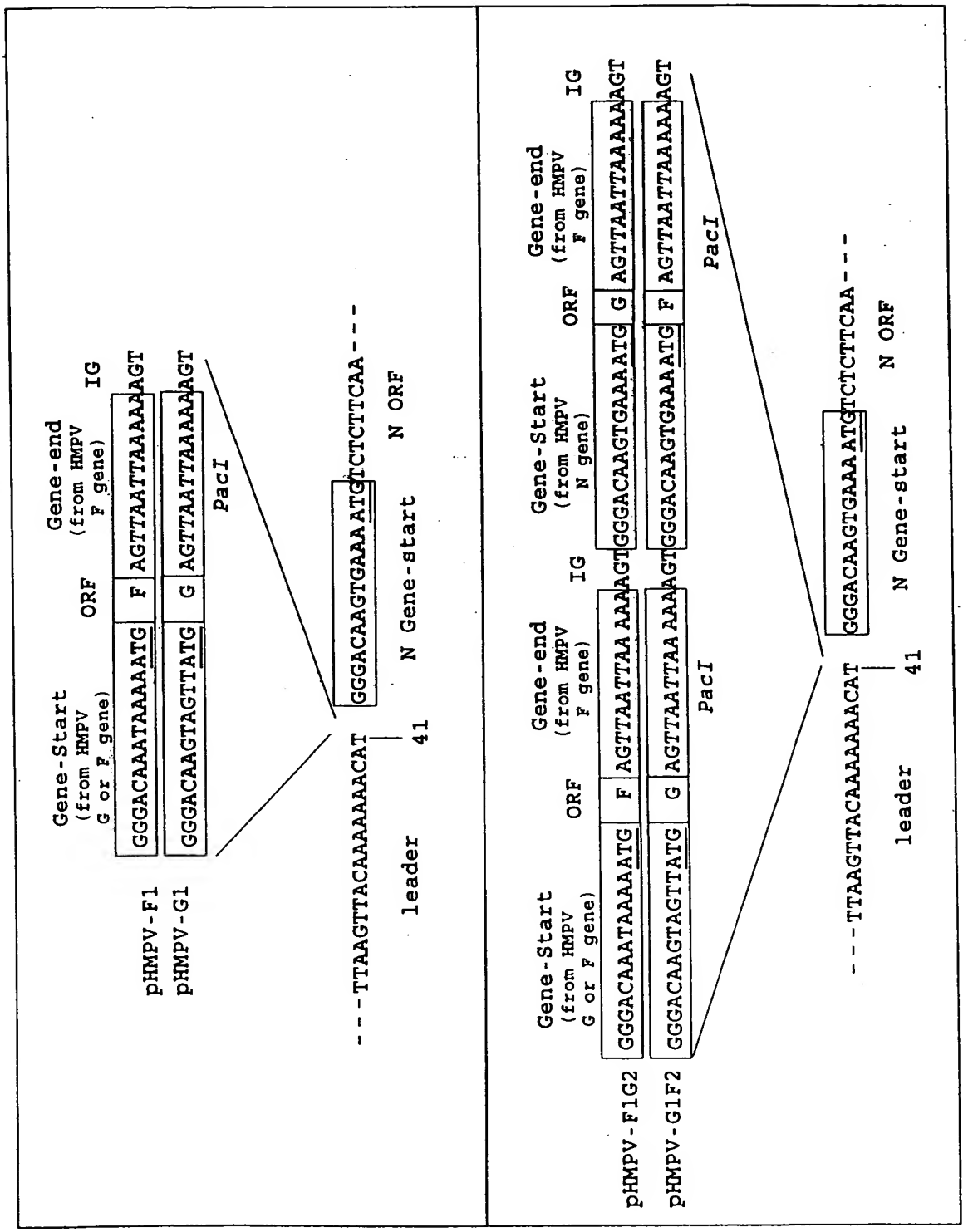

Gene-Start (from HMPV G or F gene)
ORF
Gene-end (from HMPV F gene)
IG
pHMPV-F1
GGGACAAATAAAAATG
F
AGTTAATTAAAAAAGT
pHMPV-G1
GGGACAAGTAGTTATG
G
AGTTAATTAAAAAAGT
PacI
---TTAAGTTACAAAAAAACAT
GGGACAAGTGAAAATGTCTCTTCAA---
leader
41
N Gene-start
N ORF
Gene-Start (from HMPV G or F gene)
ORF
Gene-end (from HMPV F gene)
IG
Gene-Start (from HMPV N gene)
ORF
Gene-end (from HMPV F gene)
IG
pHMPV-F1G2
GGGACAAATAAAAATG
F
AGTTAATTAA AAAAGT
GGGACAAGTGAAAATG
G
AGTTAATTAAAAAAGT
pHMPV-G1F2
GGGACAAGTAGTTATG
G
AGTTAATTAA AAAAGT
GGGACAAGTGAAAATG
F
AGTTAATTAAAAAAGT
PacI
---TTAAGTTACAAAAAAACAT
GGGACAAGTGAAAATGTCTCTTCAA---
leader
41
N Gene-start
N ORF

Fig. 24A

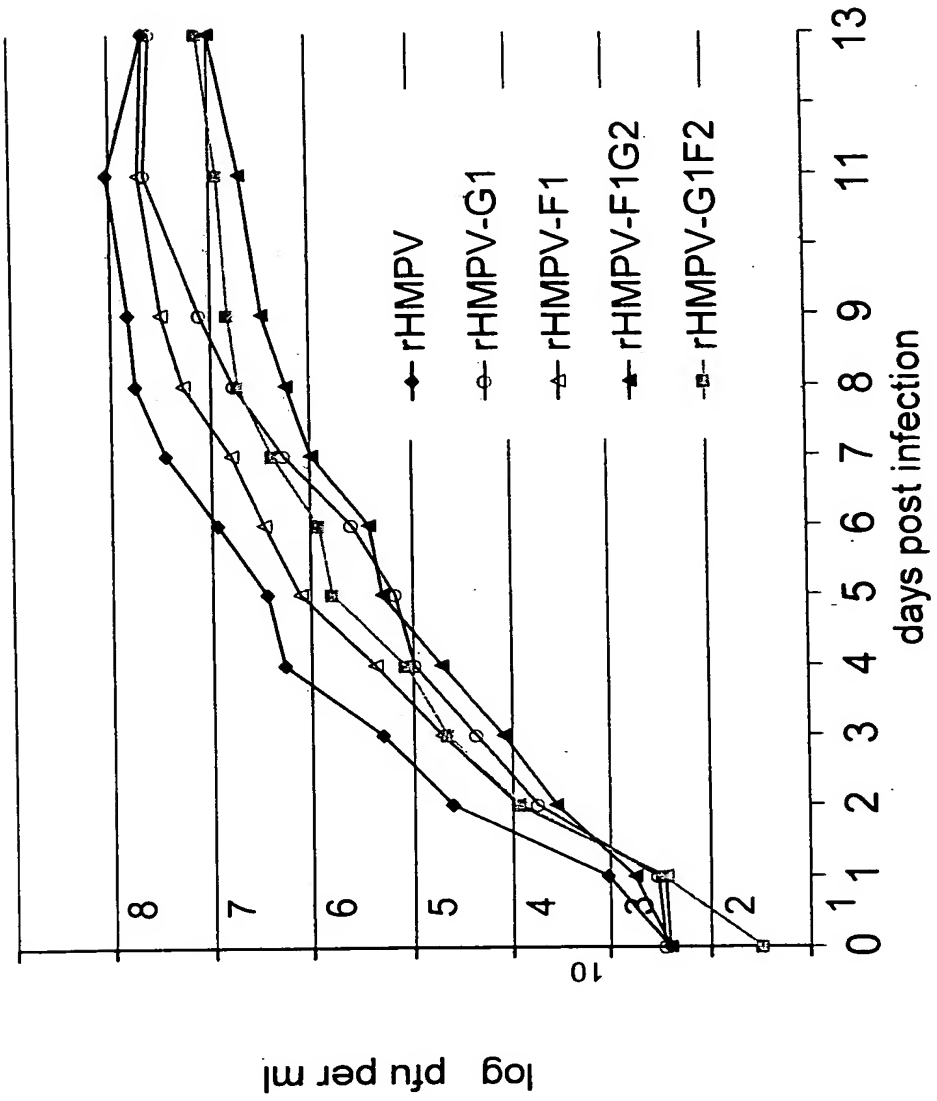

log pfu per ml
10
8
7
6
5
4
3
2
0 1 2 3 4 5 6 7 8 9 11 13
days post infection
rHMPV
rHMPV-G1
rHMPV-F1
rHMPV-F1G2
rHMPV-G1F2

Fig. 24B

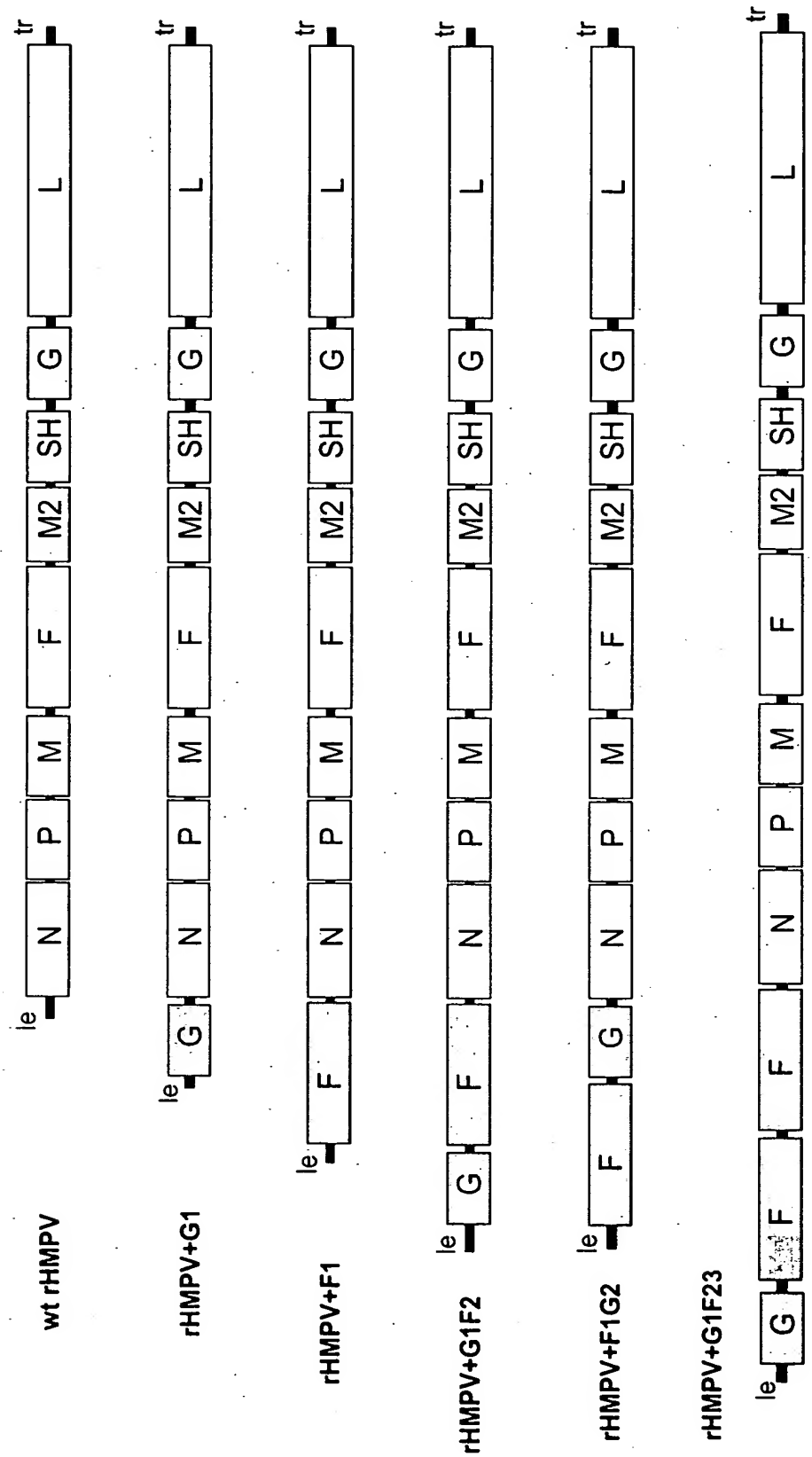

wt rHMPV
rHMPV+G1
rHMPV+F1
rHMPV+G1F2
rHMPV+F1G2
rHMPV+G1F23
le
tr
N
P
M
F
M2
SH
G
L

Fig. 25A

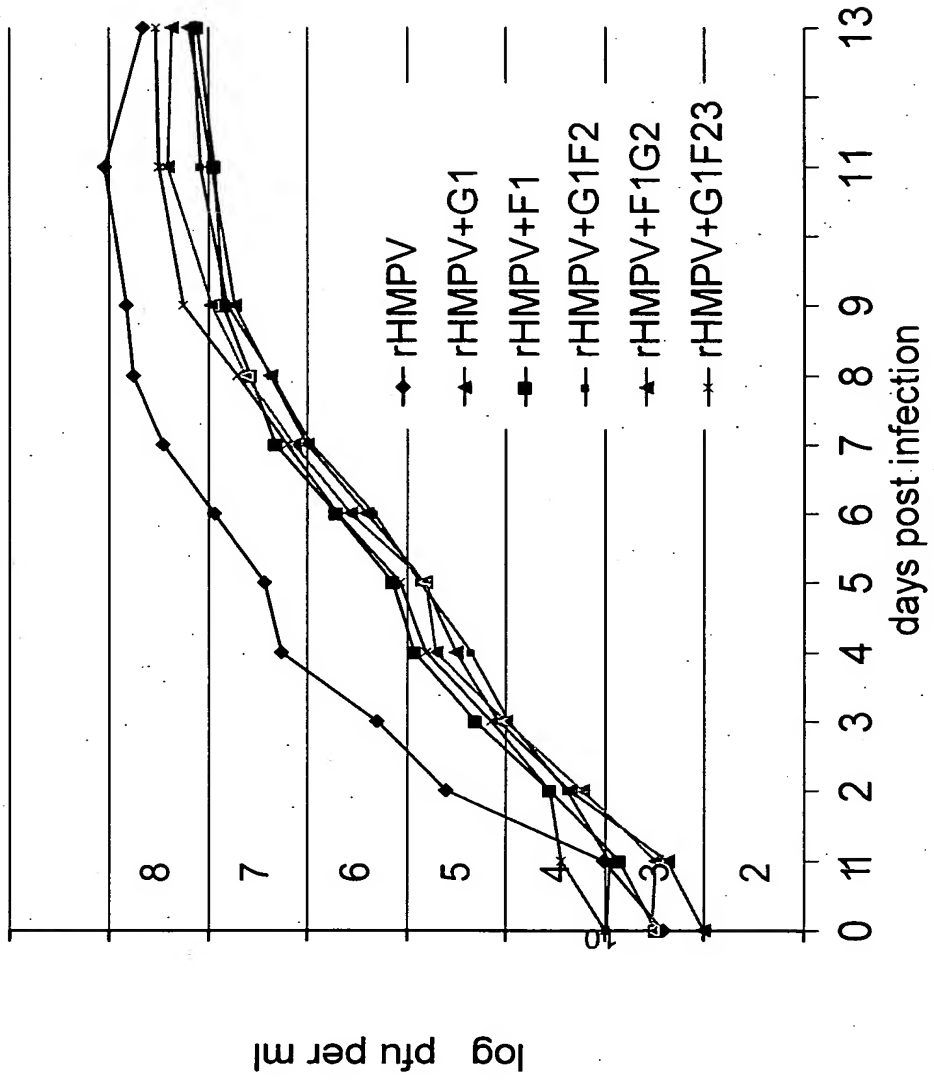

log pfu per ml
8
7
6
5
4
3
2
0 1 2 3 4 5 6 7 8 9 11 13
days post infection
rHMPV
rHMPV+G1
rHMPV+F1
rHMPV+G1F2
rHMPV+F1G2
rHMPV+G1F23

Fig. 25B

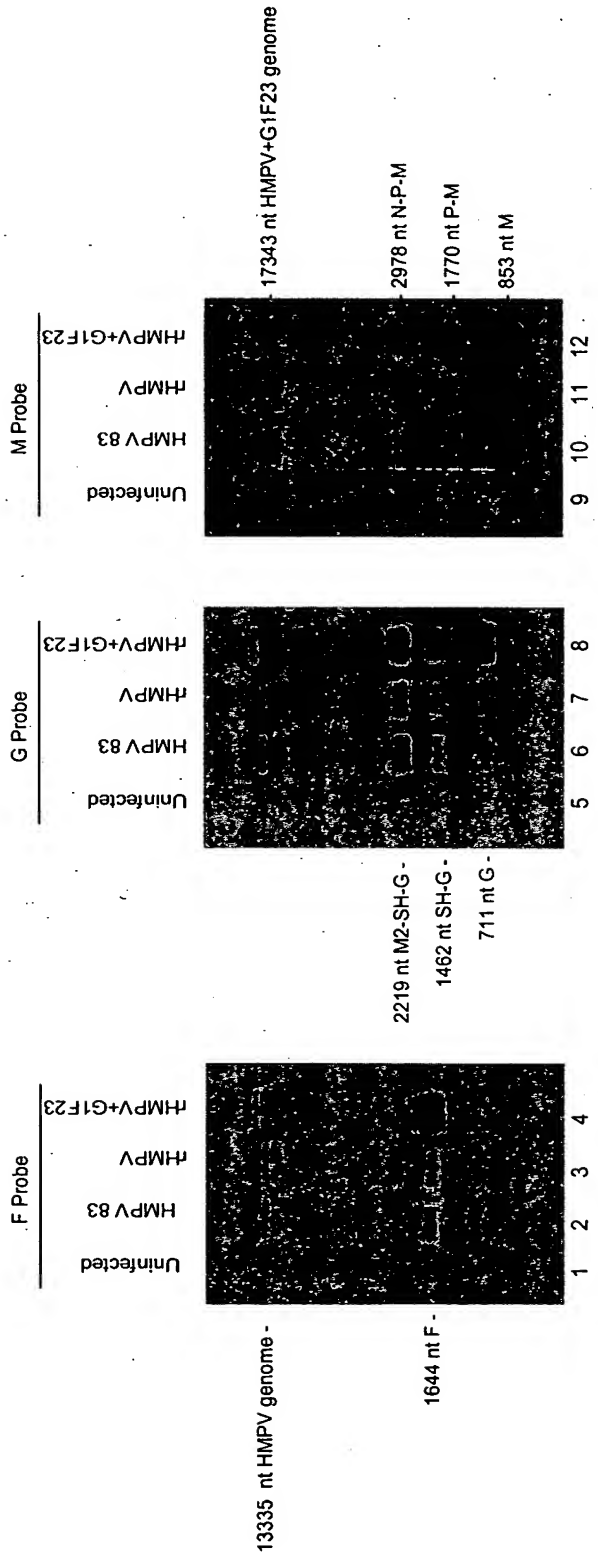

F Probe
Uninfected
HMPV 83
rHMPV
rHMPV+G1F23
1
2
3
4
13335 nt HMPV genome -
1644 nt F -
G Probe
Uninfected
HMPV 83
rHMPV
rHMPV+G1F23
5
6
7
8
2219 nt M2-SH-G -
1462 nt SH-G -
711 nt G -
M Probe
Uninfected
HMPV 83
rHMPV
rHMPV+G1F23
9
10
11
12
17343 nt HMPV+G1F23 genome
2978 nt N-P-M
1770 nt P-M
853 nt M

Fig. 25C

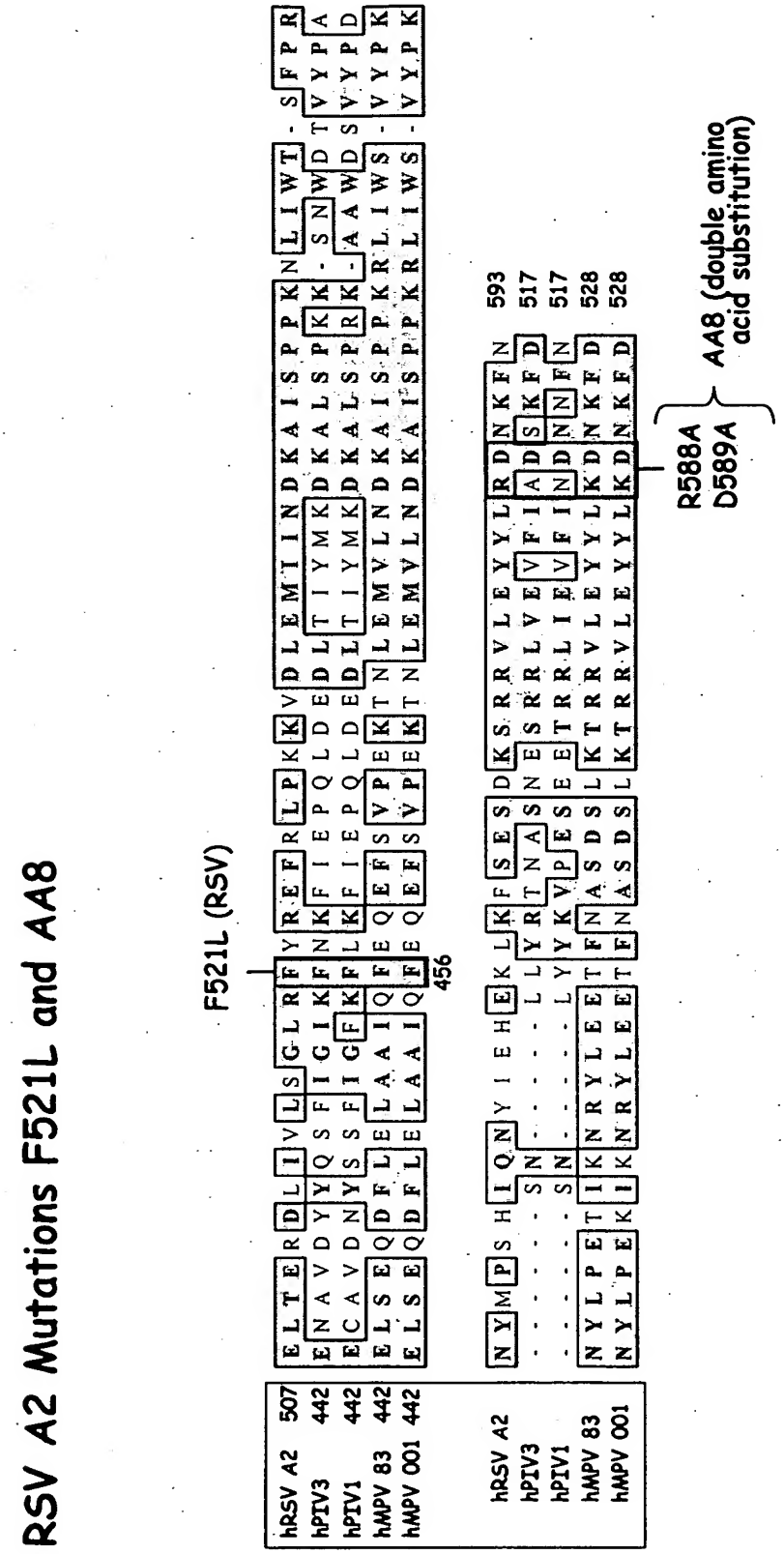

RSV A2 Mutations F521L and AA8
F521L (RSV)
456
R588A
D589A
AA8 (double amino acid substitution)
hRSV A2 507
hPIV3 442
hPIV1 442
hMPV 83 442
hMPV 001 442
hRSV A2 593
hPIV3 517
hPIV1 517
hMPV 83 528
hMPV 001 528

Fig. 26A

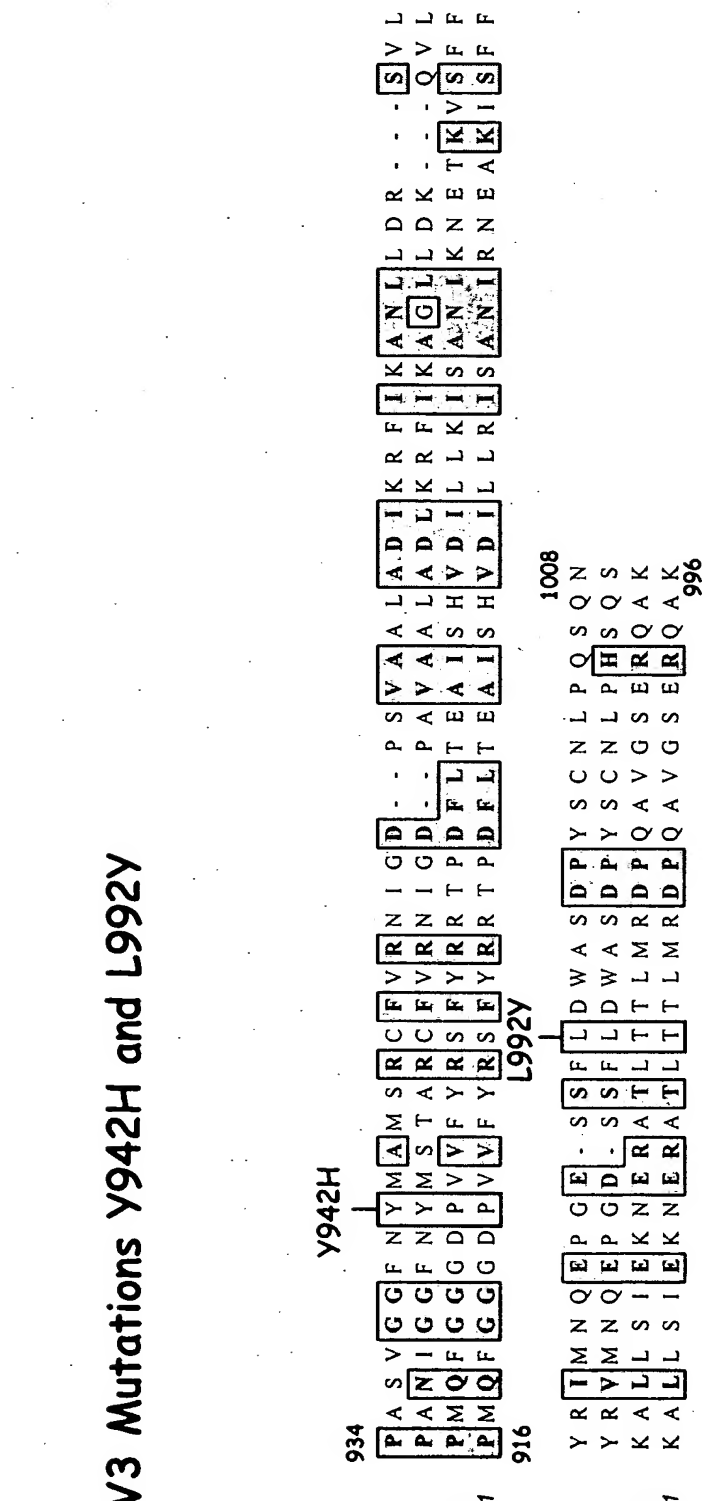
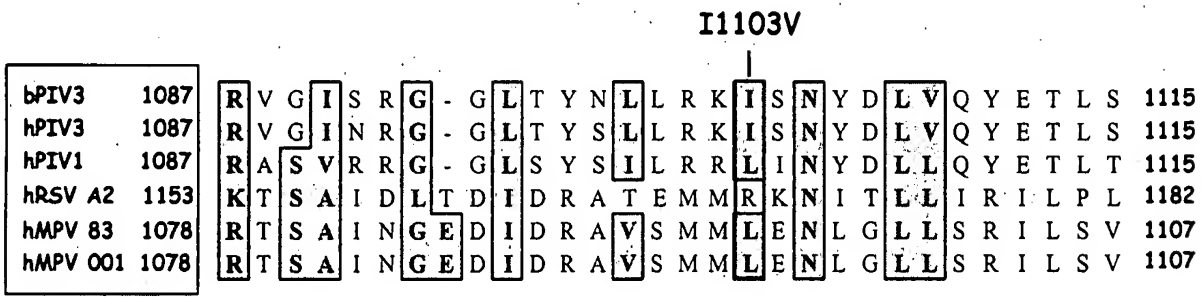
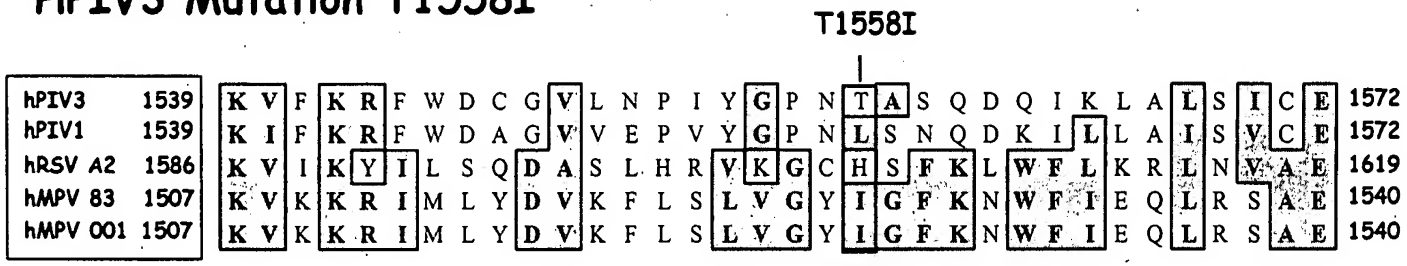

HPIV3 Mutations Y942H and L992Y
Y942H
L992Y
934
916
1008
996
hPIV3
hPIV1
hMPV 83
hMPV 001
P A S V G G F N Y M A M S R C F V R N I G D - - P S V A A L A D I K R F I K A N L L D R - - - S V L
P A N I G G F N Y M S T A R C F V R N I G D - - P A V A A L A D L K R F I K A G L L D K - - - Q V L
P M Q F G G G D P V V F Y R S F Y R R T P D F L T E A I S H V D I L L L K I S A N I K N E T K V S F F
P M Q F G G G D P V V F Y R S F Y R R T P D F L T E A I S H V D I L L R I S A N I R N E A K I S F F
Y R I M N Q E P G E - S S F L D W A S D P Y S C N L P Q S S Q N
Y R Y M N Q E P G D - S S F L D W A S D P Y S C N L P H S Q S S
K A L L S I E K N E R A T L T T L M R D P Q A V G S E R Q A K
K A L L S I E K N E R A T L T T L M R D P Q A V G S E R Q A K

Fig. 26B

BPIV3 Mutation I1103V



HPIV3 Mutation T1558I



RSV A2 Mutation C319Y

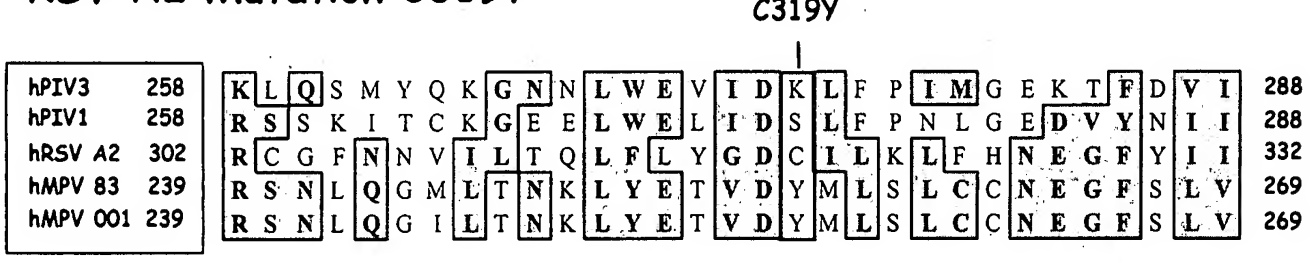
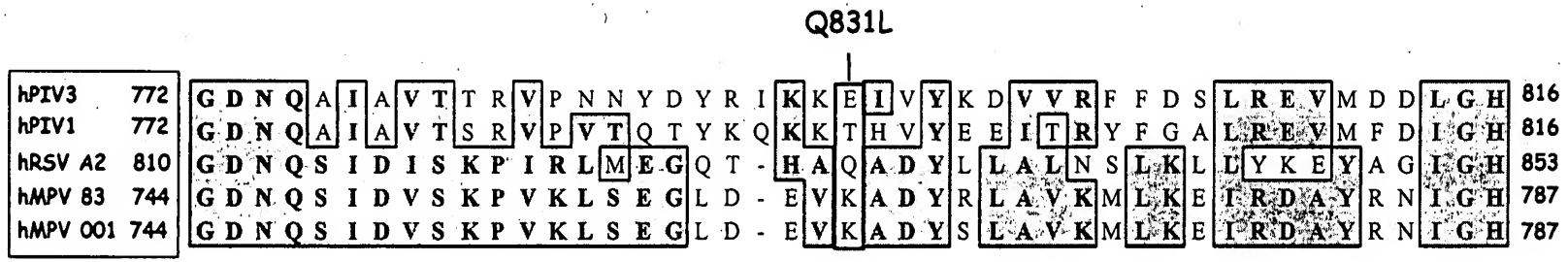


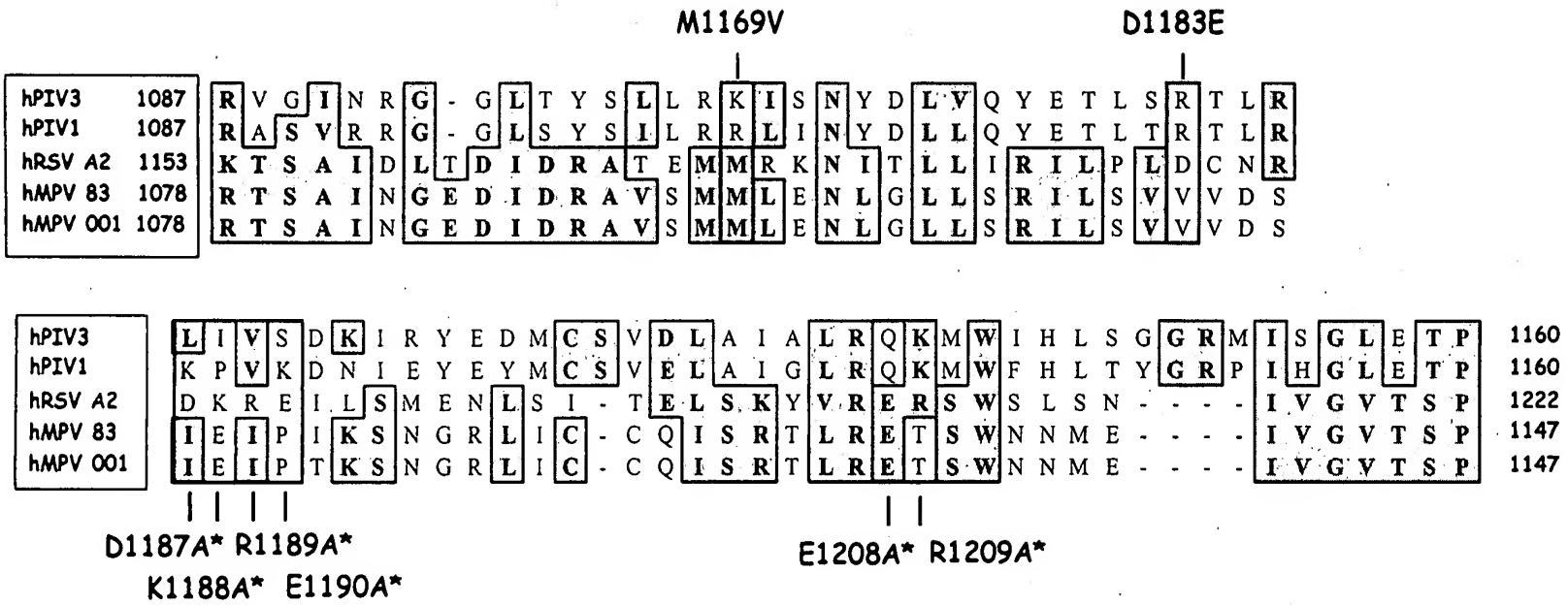
Fig. 26C

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 39 of 66 Sheets

RSV A2 Mutation Q831L



RSV A2 Mutations M1169V, D1183E and C9

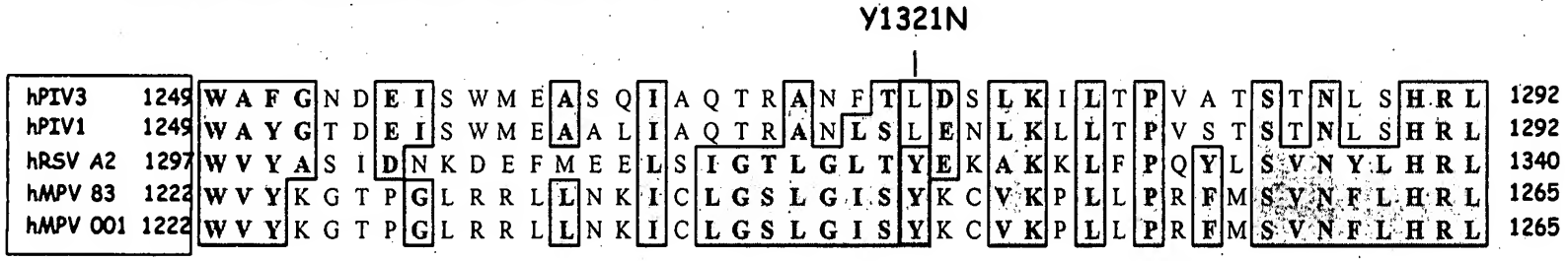


* Six point mutations collectively designated C9

Fig. 26D

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 40 of 66 Sheets

RSV A2 Mutation Y1321N



RSV A2 Mutation H1690Y

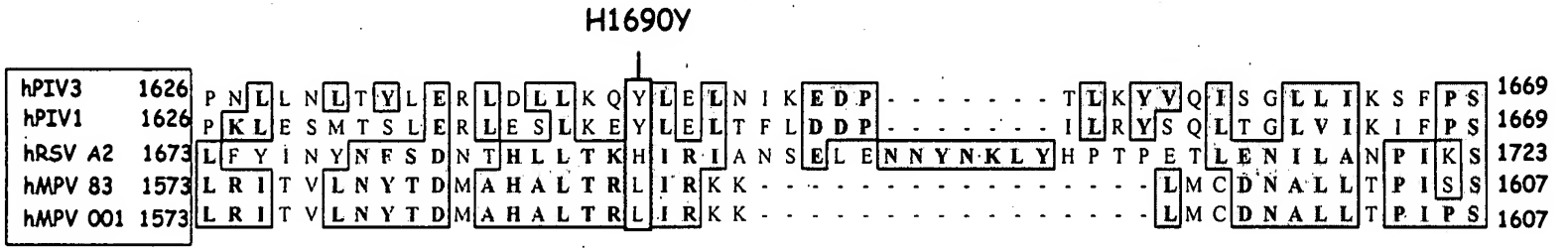
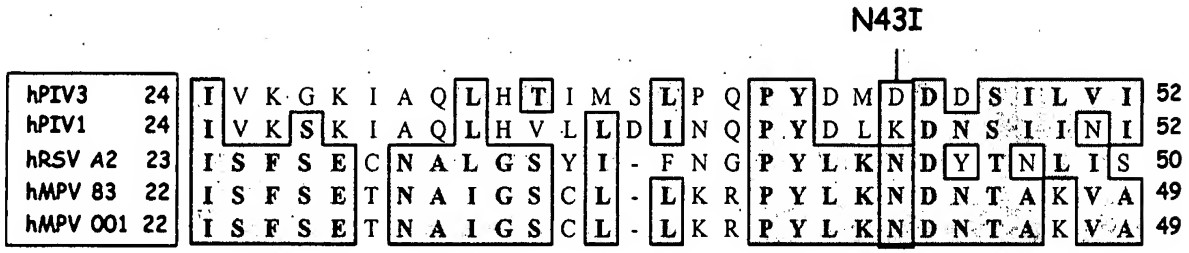


Fig. 26E

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 41 of 66 Sheets

RSV A2 Mutation N43I



BPIV3 Mutation T1711I

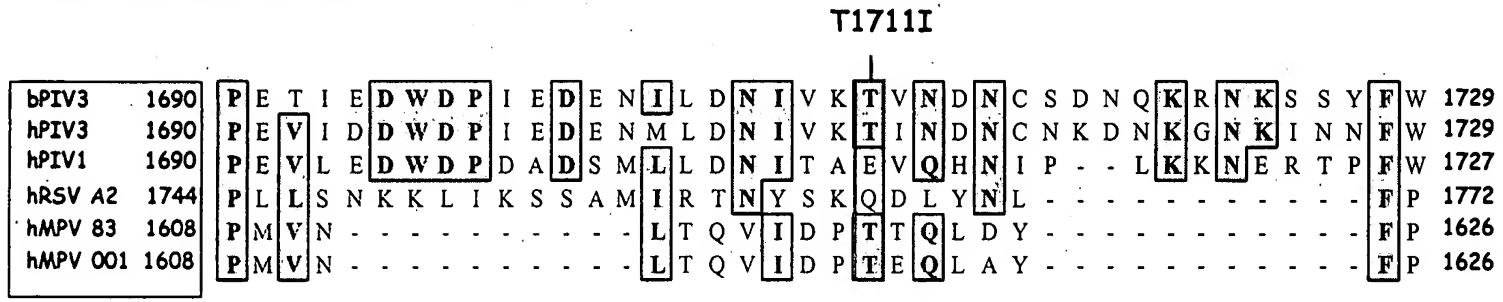


Fig. 26F

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 42 of 66 Sheets

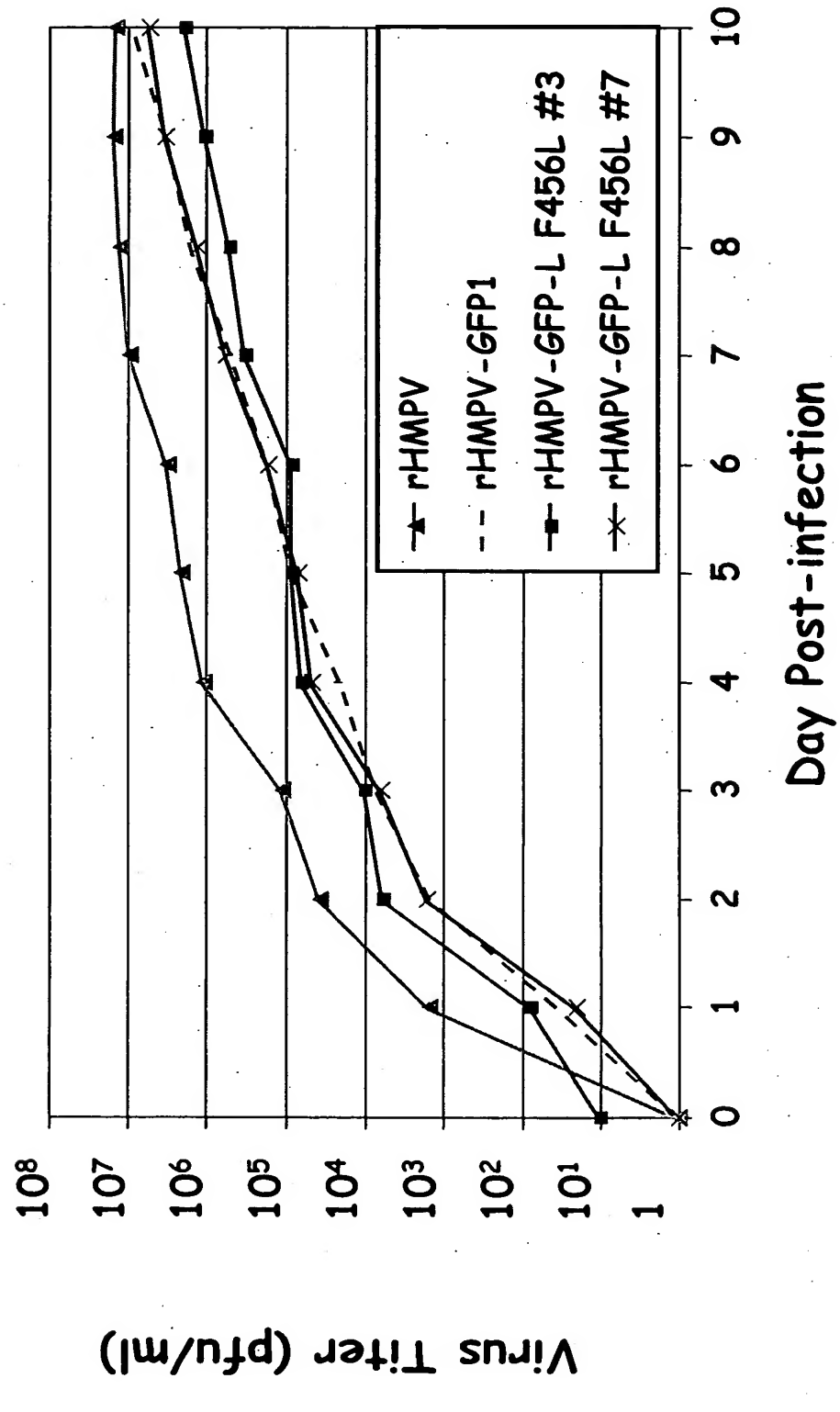

Virus Titer (pfu/ml)
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10^1
1
0
1
2
3
4
5
6
7
8
9
10
Day Post-infection
rHMPV
rHMPV-GFP1
rHMPV-GFP-L F456L #3
rHMPV-GFP-L F456L #7

Fig. 27

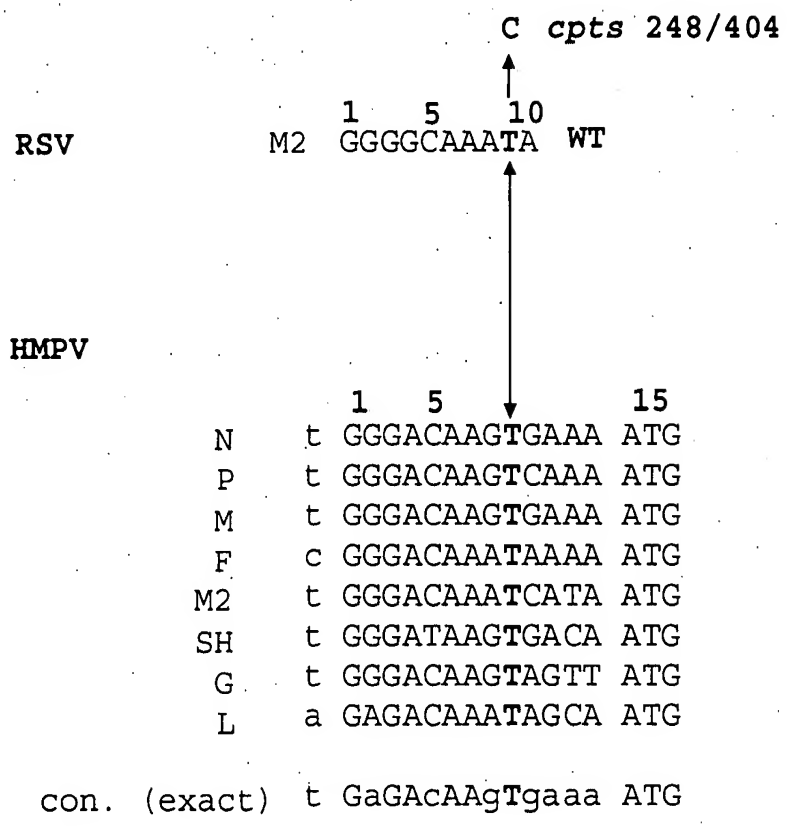
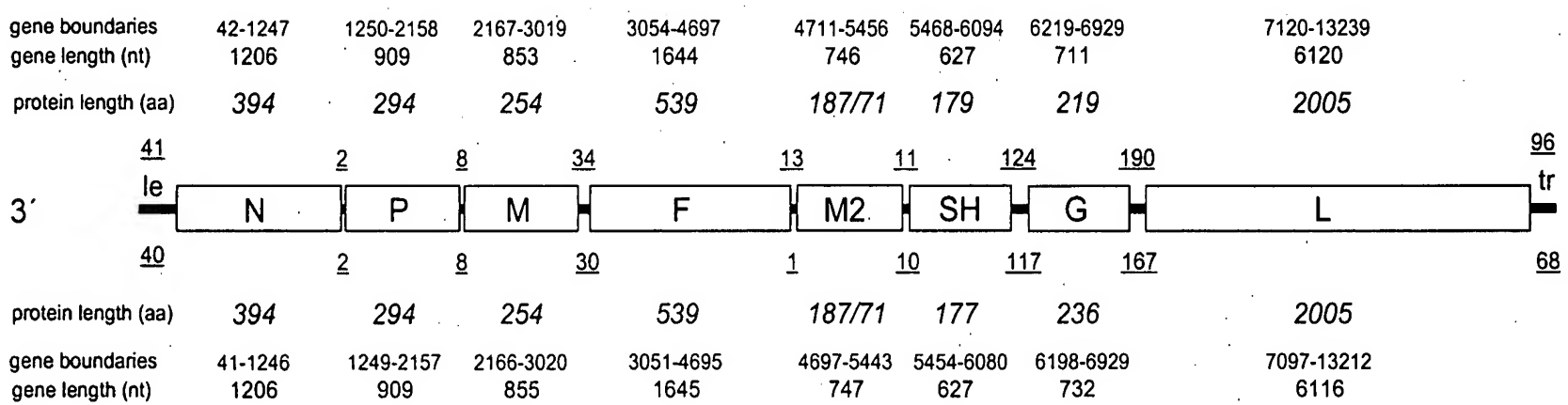


Fig. 28

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 44 of 66 Sheets

CAN97-83, 13,335 nucleotides



CAN98-75, 13,280 nucleotides

Fig. 29

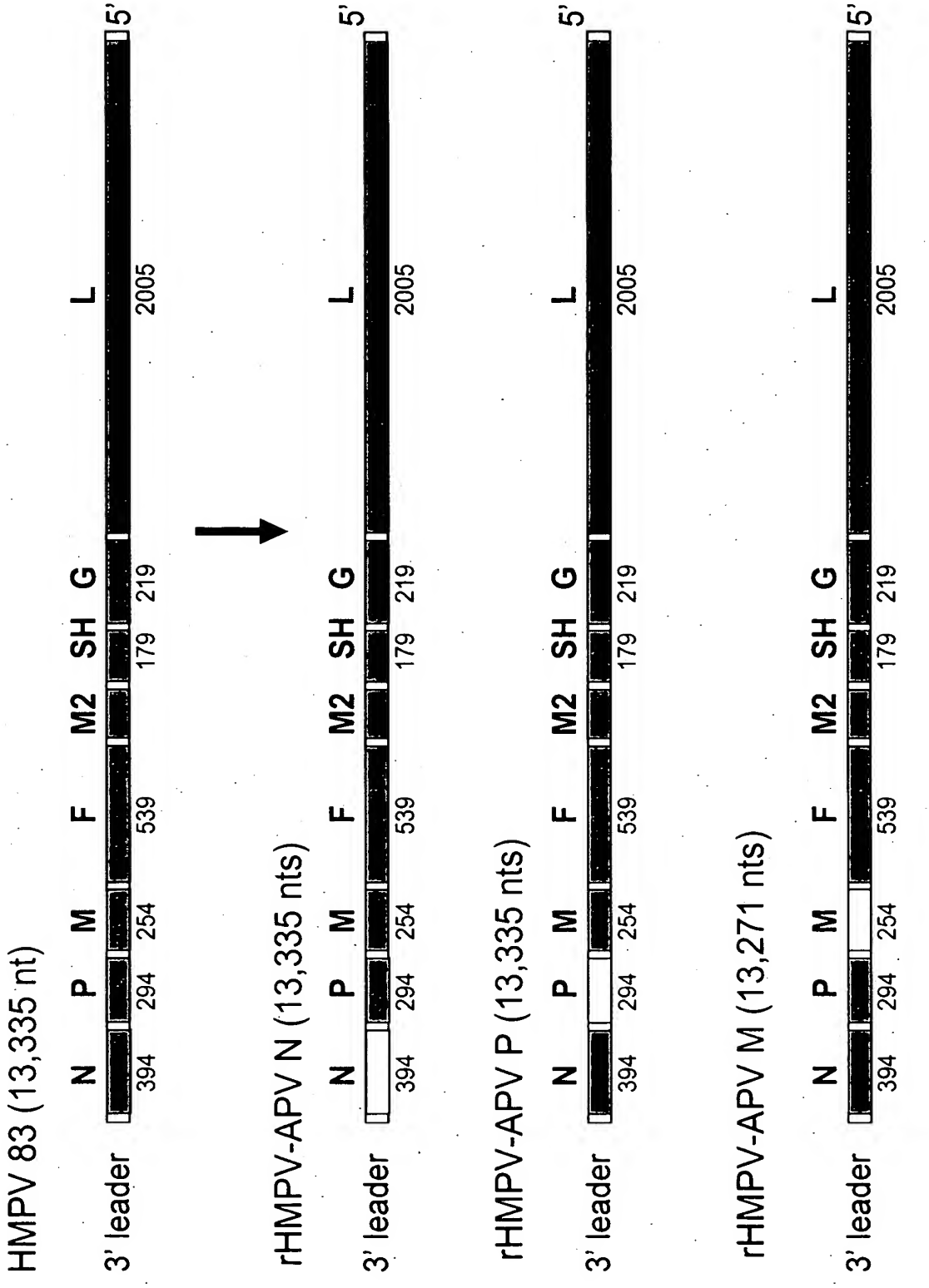

A
HMPV 83 (13,335 nt)
3' leader
N
P
M
F
M2
SH
G
L
5'
394
294
254
539
179
219
2005
rHMPV-APV N (13,335 nts)
rHMPV-APV P (13,335 nts)
rHMPV-APV M (13,271 nts)

Fig. 30A

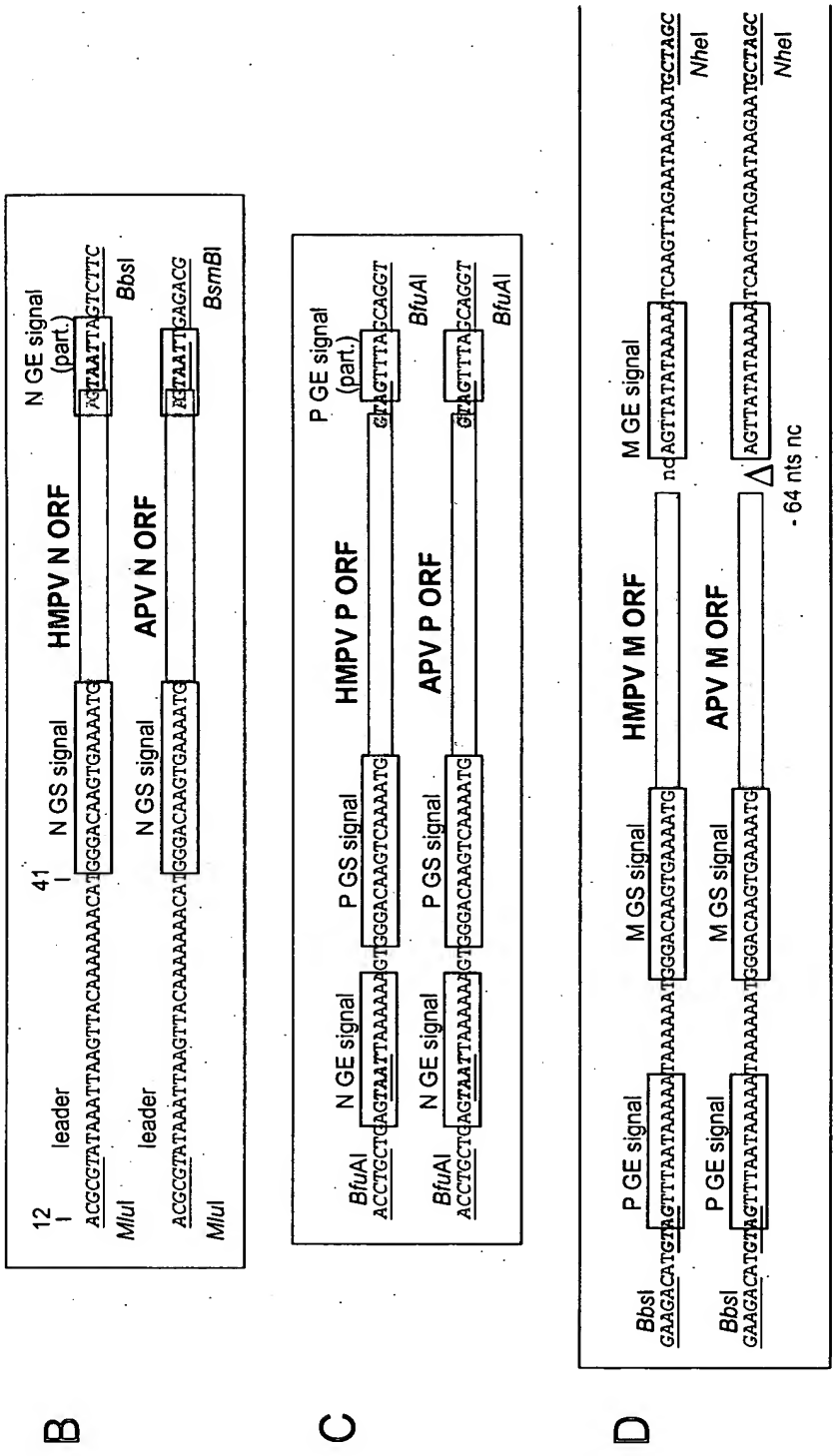

B
12
1
leader
41
1
N GS signal
HMPV N ORF
N GE signal (part.)
ACGCGTATAAATTAAGTTACAAAAAAACATGGGACAAGTGAAAATG
AGTAATTAGTCTTC
MluI
BbsI
leader
N GS signal
APV N ORF
AGTAATTGAGACG
BsmBI
C
BfuAI
N GE signal
P GS signal
HMPV P ORF
P GE signal (part.)
ACCTGCTGAGTAATTAAAAAAGTGGGACAAGTCAAAATG
GTAGTTTACAGGT
APV P ORF
D
BbsI
P GE signal
M GS signal
HMPV M ORF
M GE signal
GAAGACATGTAGTTTAATAAAAATAAAAAATGGGACAAGTGAAAATG
AGTTATATAAAAATCAAGTTAGAATAAGAATGCTAGC
NheI
APV M ORF
- 64 nts nc
E
MluI (12)
TAAT
N
+
TAAT
GTAG
P
+
GTAG
NheI (3038)
M
MluI (12)
NheI (3038)
rHMPV
1 N P M F M2 SH G L 13335

Fig. 30B-E

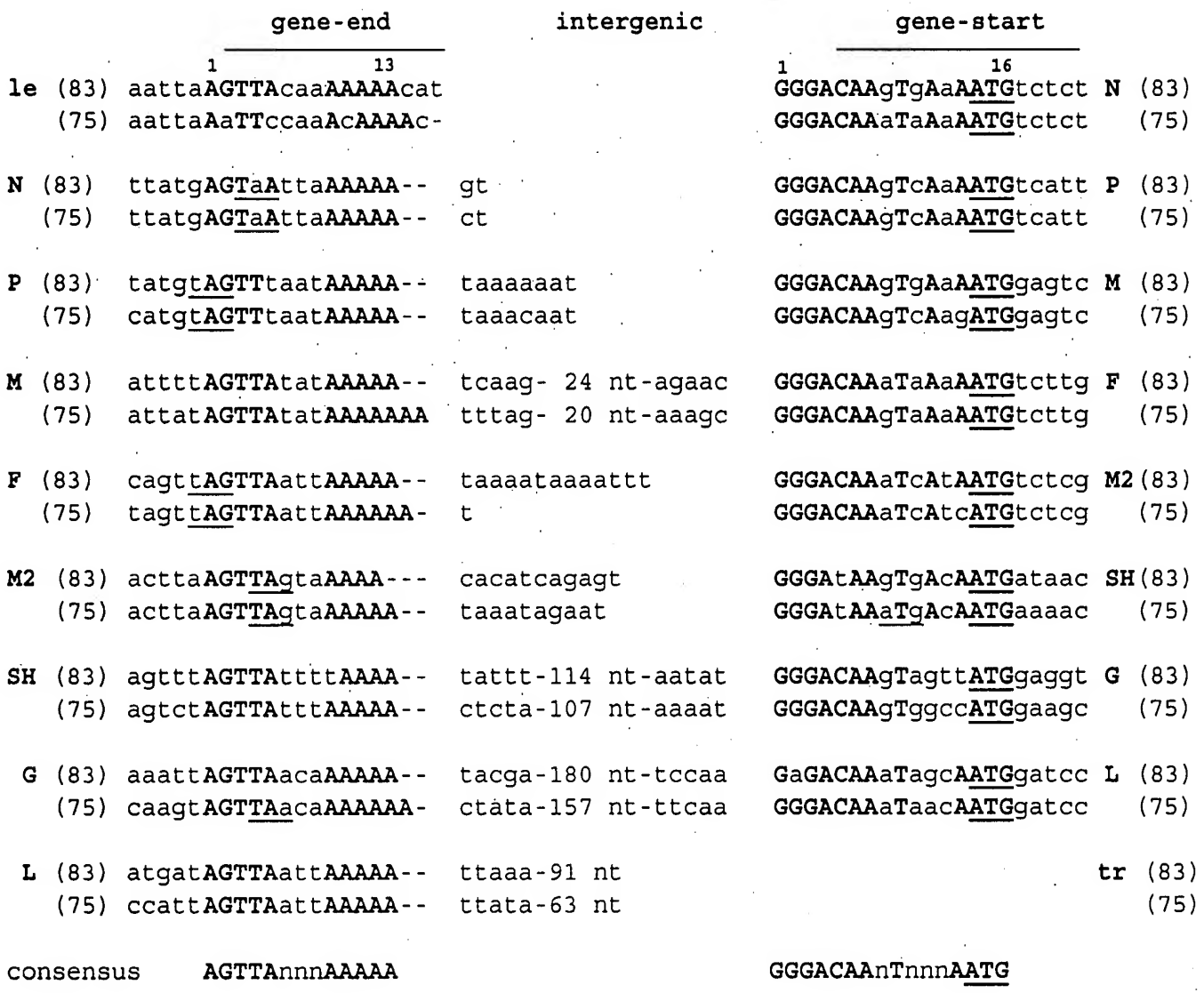

gene-end
intergenic
gene-start
1
13
1
16
le (83) aattaAGTTAcaaAAAAAcat GGGACAAgTgAaAATGtctct N (83)
(75) aattaAaTTccaaAcAAAAc- GGGACAAaTaAaAATGtctct (75)
N (83) ttatgAGTaAttaAAAAA-- gt GGGACAAgTcAaAATGtcatt P (83)
(75) ttatgAGTaAttaAAAAA-- ct GGGACAAgTcAaAATGtcatt (75)
P (83) tatgtAGTTtaatAAAAA-- taaaaaat GGGACAAgTgAaAATGgagtc M (83)
(75) catgtAGTTtaatAAAAA-- taaacaat GGGACAAgTcAagATGgagtc (75)
M (83) attttAGTTAtatAAAAA-- tcaag- 24 nt-agaac GGGACAAaTaAaAATGtcttg F (83)
(75) attatAGTTAtatAAAAAAA tttag- 20 nt-aaagc GGGACAAgTaAaAATGtcttg (75)
F (83) cagttAGTTAattAAAAA-- taaaataaaattt GGGACAAaTcAtAATGtctcg M2 (83)
(75) tagttAGTTAattAAAAAA- t GGGACAAaTcAtcATGtctcg (75)
M2 (83) acttaAGTTAgtaAAAA--- cacatcagagt GGGAtAAgTgAcAATGataac SH (83)
(75) acttaAGTTAgtaAAAAA-- taaatagaat GGGAtAAaTgAcAATGaaaac (75)
SH (83) agtttAGTTAttttAAAA-- tattt-114 nt-aatat GGGACAAgTagttATGgaggt G (83)
(75) agtctAGTTAtttAAAAA-- ctcta-107 nt-aaaat GGGACAAgTggccATGgaagc (75)
G (83) aaattAGTTAacaAAAAA-- tacga-180 nt-tccaa GaGACAAaTagcAATGgatcc L (83)
(75) caagtAGTTAacaAAAAAA- ctata-157 nt-ttcaa GGGACAAaTaacAATGgatcc (75)
L (83) atgatAGTTAattAAAAA-- ttaaa-91 nt tr (83)
(75) ccattAGTTAattAAAAA-- ttata-63 nt (75)
consensus AGTTAnnnAAAAA GGGACAAnTnnnAATG

Fig. 31

Percent amino acid or nucleotide sequence identity between the indicated strains of HMPV or RSV for the indicated proteins and ORFs

Viruses compared	percent amino acid sequence identity for indicated protein (percent nucleotide sequence identity for indicated ORF)								
	N	P	M	F	M2-1	M2-2	SH	G	L
CAN97-83 vs CAN98-75	96 (84)	85 (81)	97 (85)	95 (84)	96 (85)	89 (87)	59 (69)	37 (59)	94 (84)
CAN97-83 vs 00-1	99 (94)	95 (92)	99 (94)	98 (94)	98 (94)	96 (95)	85 (88)	70 (77)	99 (95)
RSV A2 vs RSV B1	95 (85)	90 (85)	91 (85)	89 (81)	91 (84)	61 (69)	72 (77)	55 (67)	92 (85)

Fig. 32

A. SH protein

```
CAN98-75    1  K           E  NQ      K    L   S PT     S  V   V  T   54
CAN97-83    1 MITLDVIKSDGSSKTCTHLKKIIKDHSGKVLIALKLILALLTFFTITITINYIK  54
00-1        1                                 V          L V          54
              * *********** **..****** ****.**  *  *****  *.***.** *
                             •

CAN98-75   55       A  L N    K TKL    T IRPIP LNAV  L     KH N  TKD 108
CAN97-83   55 VENNLQICQSKTESDKEDSPSNTTSVTTKTTLDHDITQYFKRLIQRYTDSVIN- 107
00-1       55                 K  SS           N        SL    TN A  - 107
              ****** ** *.**** *.  **** *  .        ** * ***. * *
                     •

CAN98-75  109 R    R HT      KI      GSMN TNTD EEP V  DK   TMT KHRKA 162
CAN97-83  108 KDTCWKISRNQCTNITTYKFLCFKPEDSKINSCDRLTDLCRNKSKSAAEAYHTV 161
00-1      108 S      N                S   T T N  K        P P VGV  I 161
               ****.*  ******  ******     .  . *.   * **   * *     .
                 •       •          •          •       •

CAN98-75  163    RPH T  W HYL------- 177
CAN97-83  162 ECHCIYTIEWKCYHHSID---- 179
00-1      162        VK     YPT ETQS 183
              ***    *  *  *
               •          •
```

Fig. 33A

B. G protein

```
CAN98-75     1  AR          F  KM   IRS   HR  T      S AP M    TL    DHA  54
CAN97-83     1 MEVKVENIRAIDMLKARVKNRVARSKCFKNASLILIGITTLSIALNIYLIINYT  54
00-1         1          T                        V                     K  54
               **  .*****.*** **..***.  ***  .**.*.*** *. *.***   ***

CAN98-75    55 TS NMTKV  CVNM  V PS KTPMT AAD NTK  P QA  LT  DS SLA T 108
CAN97-83    55 IQKTSSESEHHTSSPPTESNKEASTISTDNPDINPNSQHPTQQSTENPTLNPAA 108
00-1        55 M  NT         S M  SR TP VP   S T SSP        GS  YF   108
                 *. .  **      * *  . .     .          *. ** .**  *    *.

CAN98-75   109 LEDHLH GTTP   A VSQQTT EH TLLRSTNRQ TQ TAEKKPTRATTKKET 162
CAN97-83   109 SVSPSETEPASTPDTTNRLSSVDRSTAQPSESRTKTKPTVHTRNNPSTASSTQS 162
00-1       109  A SP     T         PPF  TH TP  A      S A    K    R S R H  162
                      *   .***.*       *  *.     . .*  .    .      ...    .

CAN98-75   163 TT T ST ATQTLNTTNQTSNG EA    AR RNNA   SSDQ TQ ADPS Q  216
CAN97-83   163 PPRATTKAIRRATTFRMSSTGKR-PTTTSVQSDSSTTTQNHEETGSANPQASVS 215
00-1       163       RTA  T  L T   R  - S A   P I A  HKN  ASP S   T A  215
                 *.*.  .   .. .     ..  *   .*.* .     .**.   ...  *    .* *

CAN98-75   217 QHTQKSTTTTHNTDTSSPSS- 236
CAN97-83   216 TMQN----------------- 219
00-1       216  TRIQRKSVEANTSTTYNQTS 236
```

Fig. 33B

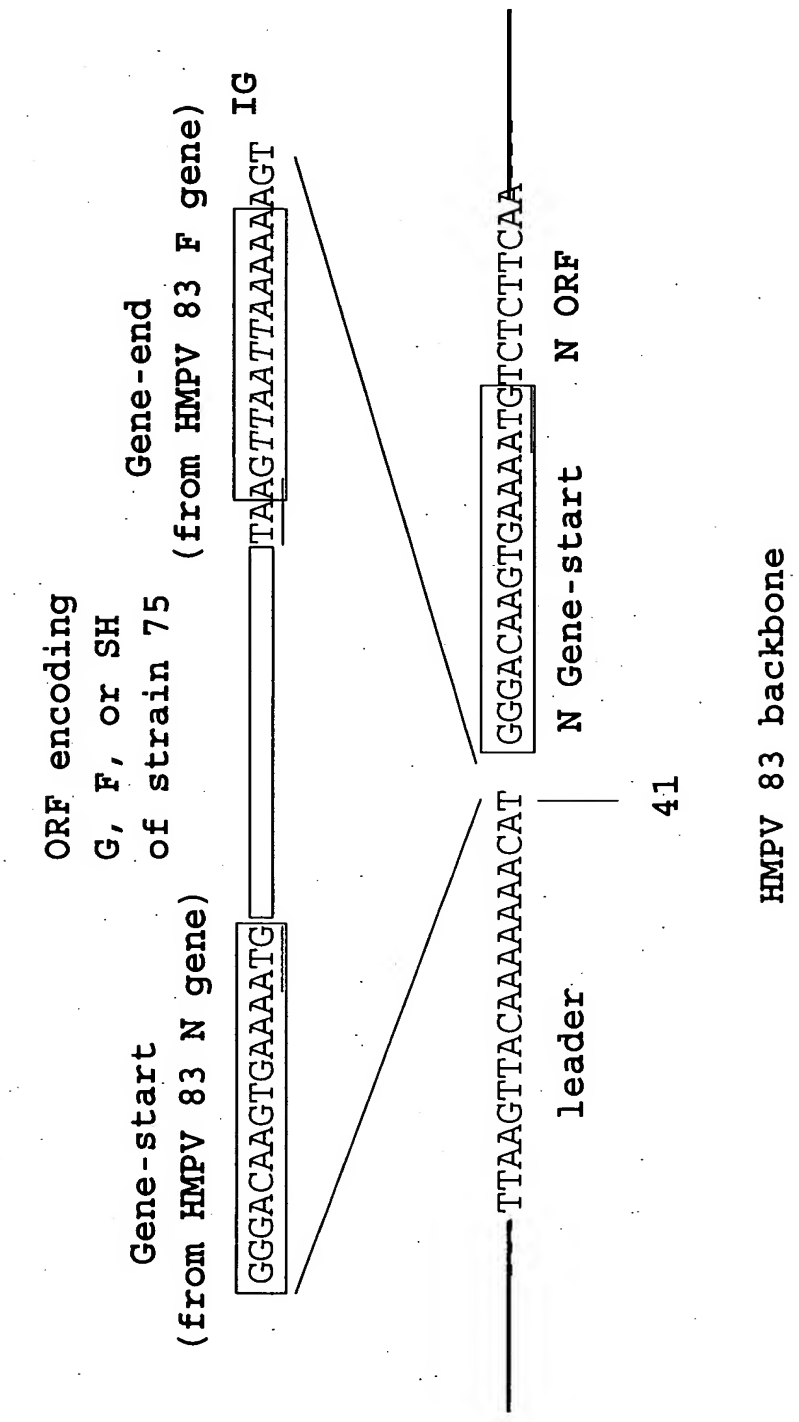
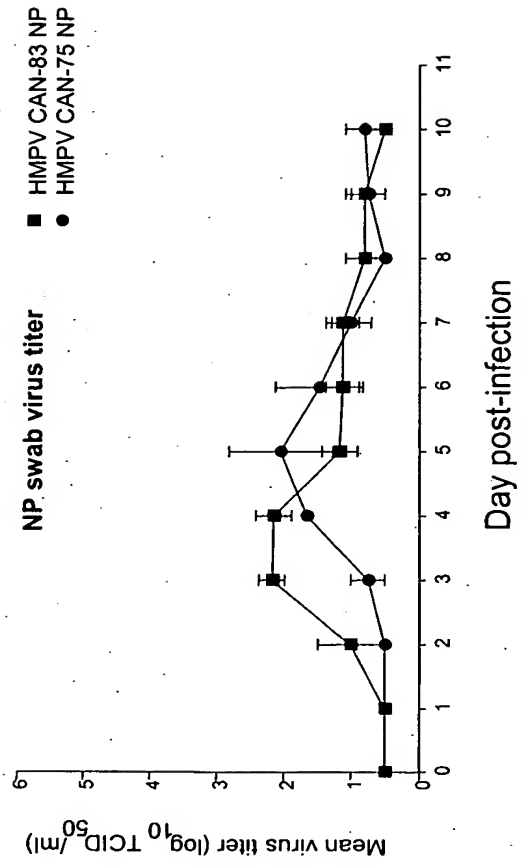

ORF encoding
G, F, or SH
of strain 75
Gene-start
(from HMPV 83 N gene)
GGGACAAGTGAAAATG
Gene-end
(from HMPV 83 F gene)
TAAGTTAATTAAAAAAGT
IG
TTAAGTTACAAAAAAACAT
leader
41
GGGACAAGTGAAAATGTCTCTTCAA
N Gene-start
N ORF
HMPV 83 backbone

Fig. 34


NP swab virus titer
HMPV CAN-83 NP
HMPV CAN-75 NP
Mean virus titer (log10 TCID50/ml)
Day post-infection
0
1
2
3
4
5
6
7
8
9
10
11

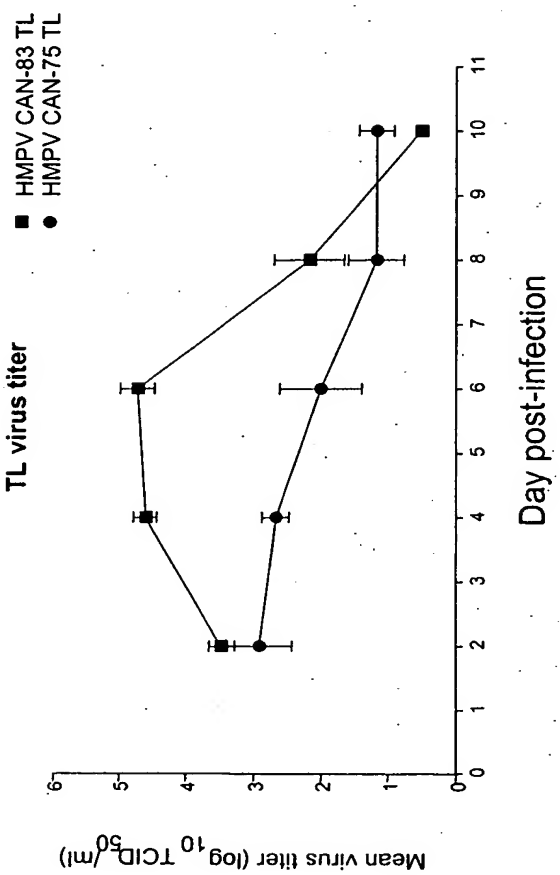
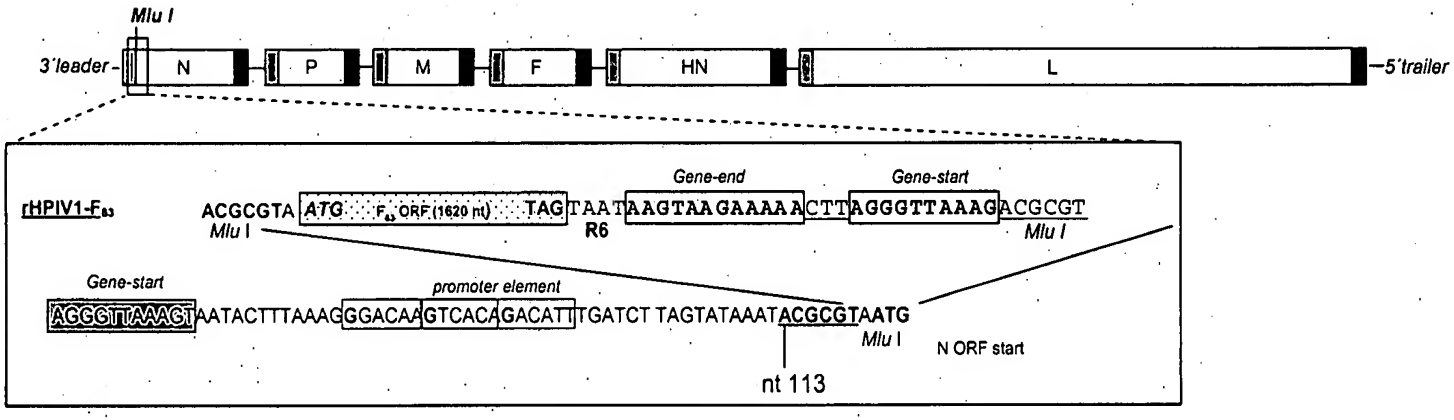

TL virus titer
HMPV CAN-83 TL
HMPV CAN-75 TL
Mean virus titer (log10 TCID50/ml)
Day post-infection
0
1
2
3
4
5
6
7
8
9
10
11

Fig. 35

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 54 of 66 Sheets

A.



B.

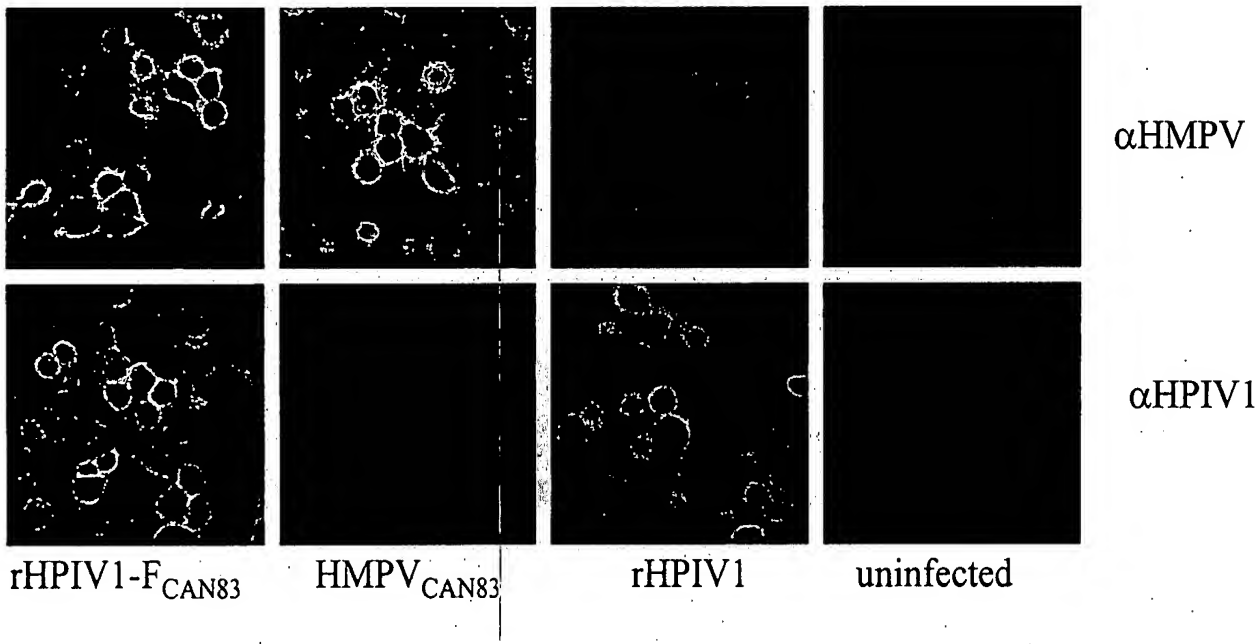


Fig. 36A & B

HMPV strain 83

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      |   10      |   20      |   30      |   40      |   50      |   60      |   70      |   80      |   90      |  100
    1 ACGCGAAAAA AACGCGTATA AATTAAGTTA CAAAAAAACA TGGGACAAGT GAAAATGTCT CTTCAAGGGA TTCACCTGAG TGATCTATCA TACAAGCATG 100
  101 CTATATTAAA AGAGTCTCAG TATACAATAA AGAGAGATGT AGGCACAACA ACAGCAGTGA CACCCTCATC ATTGCAACAA GAAATAACAC TATTGTGTGG 200
  201 AGAAATTCTA TATGCTAAGC ATGCTGATTA CAAATATGCT GCAGAAATAG GAATACAATA TATTAGCACA GCTCTAGGAT CAGAGAGAGT ACAGCAGATT 300
  301 CTAAGAAACT CAGGCAGTGA AGTCCAAGTG GTTTTAACCA GAACGTACTC CTTGGGGAAA GTTAAAAACA ACAAAGGAGA AGATTTACAG ATGTTAGACA 400
  401 TACACGGAGT AGAGAAAAGC TGGGTGGAAG AGATAGACAA AGAAGCAAGA AAAACAATGG CAACTTTGCT TAAAGAATCA TCAGGCAATA TTCCACAAAA 500
  501 TCAGAGGCCT TCAGCACCAG ACACACCTAT AATCTTATTA TGTGTAGGTG CCTTAATATT TACCAAACTA GCATCAACTA TAGAAGTGGG ATTAGAGACC 600
  601 ACAGTCAGAA GAGCTAACCG TGTACTAAGT GATGCACTCA AAAGATACCC TAGGATGGAC ATACCAAAAA TCGCTAGATC TTTCTATGAT TTATTTGAAC 700
  701 AAAAAGTGTA TTACAGAAGT TTGTTCATTG AGTATGGCAA AGCATTAGGC TCATCCTCTA CAGGCAGCAA AGCAGAAAGT TTATTCGTTA ATATATTCAT 800
  801 GCAAGCTTAC GGTGCTGGTC AAACAATGCT GAGGTGGGGA GTCATTGCCA GGTCATCTAA CAATATAATG TTAGGACATG TATCTGTCCA AGCTGAGTTA 900
  901 AAACAAGTCA CAGAAGTCTA TGACCTGGTG CGAGAAATGG GCCCTGAATC TGGGCTCCTA CATTTAAGGC AAAGCCCAAA AGCTGGACTG TTATCACTAG 1000
 1001 CCAATTGTCC CAACTTTGCA AGTGTTGTTC TCGGCAATGC CTCAGGCTTA GGCATAATAG GTATGTATCG CGGGAGAGTG CCAAACACAG AACTATTTTC 1100
 1101 AGCAGCAGAA AGCTATGCCA AGAGTTTGAA AGAAAGCAAT AAAATTAACT TTTCTTCATT AGGACTCACA GATGAAGAAA AAGAGGCTGC AGAACACTTT 1200
 1201 CTAAATGTGA GTGACGACAG TCAAAATGAT TATGAGTAAT TAAAAAAGTG GGACAAGTCA AAATGTCATT CCCTGAAGGA AAAGATATTC TTTTCATGGG 1300
 1301 TAATGAAGCG GCAAAATTGG CAGAAGCTTT CCAAAAATCA TTAAGAAAAC CTAGTCATAA AAGATCTCAA TCTATTATAG GAGAAAAAGT GAACACTGTA 1400
 1401 TCTGAAACAT TGGAATTACC TACTATCAGT AGACCTACCA AACCGACCAT ATTGTCAGAG CCGAAGTTAG CATGGACAGA CAAAGGTGGG GCAATCAAAA 1500
 1501 CTGAAGCAAA GCAAACAATC AAAGTTATGG ATCCTATTGA AGAAGAAGAG TTTACTGAGA AAAGGGTGCT GCCCTCCAGT GATGGGAAAA CTCCTGCAGA 1600
 1601 AAAGAAGTTG AAACCATCAA CCAATACTAA AAAGAAGGTC TCATTTACAC CAAATGAACC AGGAAAATAC ACAAAGTTGG AGAAAGATGC TCTAGACTTG 1700
 1701 CTTTCAGACA ATGAAGAAGA AGATGCAGAA TCCTCAATCT TAACCTTCGA AGAAAGAGAT ACTTCATCAT TAAGCATTGA AGCCAGACTA GAATCGATTG 1800
 1801 AGGAGAAATT AAGCATGATA TTAGGGCTAT TAAGAACACT CAACATTGCT ACAGCAGGAC CCACAGCAGC AAGAGATGGG ATCAGAGATG CAATGATTGG 1900
 1901 CATAAGGGAG GAACTAATAG CAGACATAAT AAAAGAAGCC AAGGGAAAAG CAGCAGAAAT GATGGAAGAA GAAATGAACC AGCGGACAAA AATAGGAAAC 2000
 2001 GGTAGTGTAA AATTAACTGA AAAGGCAAAG GAGCTCAACA AAATTGTTGA AGACGAGAGC ACAAGTGGTG AATCCGAAGA AGAAGAAGAA CTAAAAGACA 2100
 2101 CACAGGAAAA TAATCAAGAA GATGACATTT ACCAGTTAAT TATGTAGTTT AATAAAAATA AAAAATGGGA CAAGTGAAAA TGGAGTCCTA TCTGGTAGAC 2200
 2201 ACCTATCAAG GCATCCCTTA CACAGCAGCT GTTCAAGTTG ATCTAGTAGA AAAGGACCTG TTACCTGCAA GCCTAACAAT ATGGTTCCCC CTGTTTCAGG 2300
 2301 CCAATACACC ACCAGCAGTT CTGCTTGATC AGCTAAAGAC TCTGACTATA ACTACTCTGT ATGCTGCATC ACAAAGTGGT CCAATACTAA AAGTGAATGC 2400
 2401 ATCGGCCCAG GGTGCAGCAA TGTCTGTACT TCCCAAAAAG TTTGAAGTCA ATGCGACTGT AGCACTTGAC GAATATAGCA AATTAGAATT TGACAAACTT 2500
 2501 ACAGTCTGTG AAGTAAAAAC AGTTTACTTA ACAACCATGA AACCATATGG GATGGTATCA AAGTTTGTGA GCTCGGCCAA ACCAGTTGGC AAAAAAACAC 2600
 2601 ATGATCTAAT CGCATTATGC GATTTTATGG ATCTAGAAAA GAACACACCA GTTACAATAC CAGCATTTAT CAAATCAGTT TCTATCAAGG AGAGTGAATC 2700
 2701 AGCCACTGTT GAAGCTGCAA TAAGCAGTGA AGCAGACCAA GCTCTAACAC AAGCCAAAAT TGCACCTTAT GCGGGACTGA TCATGATTAT GACCATGAAC 2800
 2801 AATCCCAAAG GCATATTCAA GAAGCTTGGA GCTGGGACCC AAGTTATAGT AGAACTAGGA GCATATGTCC AGGCTGAAAG CATAAGTAAA ATATGCAAGA 2900
 2901 CTTGGAGCCA TCAAGGAACA AGATATGTGC TGAAGTCCAG ATAACAGCCA AGCAACCTGA CCAAGAACTA CCAACTCTAT TCTATAGACT AAAAAGTCGC 3000
 3001 CATTTTAGTT ATATAAAAAT CAAGTTAGAA TAAGAATTAA ATCAATCAAG AACGGGACAA ATAAAAATGT CTTGGAAAGT GGTGATCATT TTTTCATTGC 3100
 3101 TAATAACACC TCAACACGGT CTTAAAGAGA GCTACCTAGA AGAATCATGT AGCACTATAA CTGAGGGATA TCTTAGTGTT CTGAGGACAG GTTGGTATAC 3200
 3201 CAACGTTTTT ACATTAGAGG TGGGTGATGT AGAAAACCTT ACATGTTCTG ATGGACCTAG CCTAATAAAA ACAGAATTAG ATCTGACCAA AAGTGCACTA 3300
 3301 AGAGAGCTCA AAACAGTCTC TGCTGACCAA TTGGCAAGAG AGGAACAAAT TGAGAATCCC AGACAATCTA GGTTTGTTCT AGGAGCAATA GCACTCGGTG 3400
 3401 TTGCAACAGC AGCTGCAGTC ACAGCAGGTG TTGCAATTGC CAAAACCATC CGGCTTGAGA GTGAAGTCAC AGCAATTAAG AATGCCCTCA AAACGACCAA 3500
 3501 TGAAGCAGTA TCTACATTGG GGAATGGAGT TCGAGTGTTG GCAACTGCAG TGAGAGAGCT GAAAGACTTT GTGAGCAAGA ATTTAACTCG TGCAATCAAC 3600
 3601 AAAAACAAGT GCGACATTGA TGACCTAAAA ATGGCCGTTA GCTTCAGTCA ATTCAACAGA AGGTTTCTAA ATGTTGTGCG GCAATTTTCA GACAATGCTG 3700
 3701 GAATAACACC AGCAATATCT TTGGACTTAA TGACAGATGC TGAACTAGCC AGGGCCGTTT CTAACATGCC GACATCTGCA GGACAAATAA AATTGATGTT 3800
```

Fig. 37A

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 55 of 66 Sheets

HMPV strain 83 (continued)

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3901 ATAGACACGC CTTGCTGGAT AGTAAAAGCA GCCCCTTCTT GTTCCGGAAA  AAAGGGAAAC TATGCTTGCC TCTTAAGAGA AGACCAAGGG TGGTATTGTC 4000
4001 AGAATGCAGG GTCAACTGTT TACTACCCAA ATGAGAAAGA CTGTGAAACA  AGAGGAGACC ATGTCTTTTG CGACACAGCA GCGGGAATTA ATGTTGCTGA 4100
4101 GCAATCAAAG GAGTGCAACA TCAACATATC CACTACAAAT TACCCATGCA  AAGTCAGCAC AGGAAGACAT CCTATCAGTA TGGTTGCACT GTCTCCTCTT 4200
4201 GGGGCTCTGG TTGCTTGCTA CAAAGGAGTA AGCTGTTCCA TTGGCAGCAA  CAGAGTAGGG ATCATCAAGC AGCTGAACAA GGGTTGCTCC TATATAACCA 4300
4301 ACCAAGATGC AGACACAGTG ACAATAGACA ACACTGTATA TCAGCTAAGC  AAAGTTGAGG GTGAACAGCA TGTTATAAAA GGCAGACCAG TGTCAAGCAG 4400
4401 CTTTGATCCA ATCAAGTTTC CTGAAGATCA ATTCAATGTT GCACTTGACC  AAGTTTTTGA GAACATTGAA AACAGCCAGG CCTTGGTAGA TCAATCAAAC 4500
4501 AGAATCCTAA GCAGTGCAGA GAAAGGGAAT ACTGGCTTCA TCATTGTAAT  AATTCTAATT GCTGTCCTTG GCTCTAGCAT GATCCTAGTG AGCATCTTCA 4600
4601 TTATAATCAA GAAAACAAAG AAACCAACGG GAGCACCTCC AGAGCTGAGT  GGTGTCACAA ACAATGGCTT CATACCACAC AGTTAGTTAA TTAAAAATAA 4700
4701 AATAAAATTT GGGACAAATC ATAATGTCTC GCAAGGCTCC ATGCAAATAT  GAAGTGCGGG GCAAATGCAA CAGAGGAAGT GAGTGTAAGT TTAACCACAA 4800
4801 TTACTGGAGT TGGCCAGATA GATACTTATT AATAAGATCA AACTATCTAT  TAAATCAGCT TTTAAGGAAC ACTGATAGAG CTGATGGCCT ATCAATAATA 4900
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5001 CAGCCTGCTA CAGTCTACAC AACATAATCA AGCAACTACA AGAAGTTGAA  GTTAGGCAGG CTAGAGATAG CAAACTATCT GACAGCAAGC ATGTGGCACT 5100
5101 CCATAACTTA ATCTTATCTT ACATGGAGAT GAGCAAAACT CCCGCATCTT  TAATCAACAA TCTCAAAAGA CTGCCGAGAG AAAAACTGAA AAAATTAGCA 5200
5201 AAGCTGATAA TTGACTTATC AGCAGGCGCT GACAATGACT CTTCATATGC  CCTGCAAGAC AGTGAAAGCA TTAATCAAGT GCAGTGAGCA TGGTCCTGTT 5300
5301 TTCATTACTA TAGAGGTTGA TGAAATGATA TGGACTCAAA AAGAATTAAA  AGAAGCTTTG TCCGATGGGA TAGTGAAGTC TCACACCAAC ATTTACAATT 5400
5401 GTTATTTAGA AAACATAGAA ATTATATATG TCAAGGCTTA CTTAAGTTAG  TAAAAACACA TCAGAGTGGG ATAAGTGACA ATGATAACAT TAGATGTCAT 5500
5501 TAAAAGTGAT GGGTCTTCAA AAACATGTAC TCACCTCAAA AAAATAATCA  AAGACCATTC TGGTAAAGTG CTTATTGCAC TTAAGTTAAT ATTAGCTTTA 5600
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5701 CATCAAATAC CACATCCGTC ACAACCAAGA CCACTCTAGA CCATGATATA  ACACAGTATT TTAAAAGATT AATTCAAAGG TATACAGATT CTGTAATAAA 5800
5801 CAAGGACACA TGCTGGAAAA TAAGCAGAAA TCAATGCACA AATATAACAA  CATATAAATT TTTATGCTTT AAACCTGAGG ACTCAAAAAT CAACAGTTGT 5900
5901 GATAGACTGA CAGATCTATG CAGAAACAAA TCAAAATCAG CAGCTGAAGC  ATATCATACA GTAGAATGCC ATTGCATATA CACAATTGAG TGGAAGTGCT 6000
6001 ATCACCACTC AATAGATTAA ACCCAATCTT GAATGTTAAA ACTAGACTAG  GATCCGTCTA AGACTATCAG TTCAATAGTT TAGTTATTTT AAAATATTTG 6100
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6201 AAGTAAAAAC AAAAATATGG GACAAGTAGT TATGGAGGTG AAAGTAGAGA  ACATTCGAGC AATAGACATG CTCAAAGCAA GAGTGAAAAA TCGTGTGGCA 6300
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6801 AGTCCAGTCC GACAGCAGCA CCACAACCCA AAATCATGAA GAAACAGGTT  CAGCGAACCC ACAGGCATCT GTAAGCACAA TGCAAAACTA GCACACCAAC 6900
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7001 CTAAAACAGC AACGACACCA TGTCAGCTTT GCTCAAATCT CTCTGGGAGA  AACTTTTGCC CACATACTAA CAACATCACA ACCATCTCAA GAAAAGAAAC 7100
7101 TGGGCAAAAC AGCATCCAAG AGACAAATAG CAATGGATCC TCTTAATGAA  TCCACTGTTA ATGTCTATCT CCCTGATTCG TACCTTAAAG GAGTAATTTC 7200
7201 TTTTAGTGAA ACTAATGCAA TTGGTTCATG TCTCTTAAAA AGACCCTACT  TAAAAAATGA CAACACTGCA AAAGTTGCCA TAGAGAATCC TGTTATTGAG 7300
7301 CATGTGAGAC TCAAAAATGC AGTCAATTCT AAAATGAAAA TATCAGATTA  CAAGGTAGTA GAGCCAGTAA ACATGCAACA TGAAATAATG AAGAATGTAC 7400
7401 ACAGTTGTGA GCTCACACTA TTGAAACAGT TTTTAACAAG GAGTAAAAAC  ATTAGCACTC TCAAATTGAA TATGATATGT GATTGGCTGC AATTAAAGTC 7500
7501 TACATCAGAT GATACCTCAA TCCTAAGTTT CATAGATGTA GAATTTATAC  CTAGTTGGGT AAGCAACTGG TTTAGTAATT GGTACAATCT CAATAAGTTA 7600
7601 ATTTTGGAAT TCAGAAGAGA GGAAGTAATA AGAACCGGTT CAATCTTATG  CAGGTCATTG GGTAAATTAG TTTTTATTGT ATCATCATAT GGATGTATCG 7700
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```

Fig. 37B

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 56 of 66 Sheets

HMPV strain 83 (continued)

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 8001 GTACTAGATT TAGAAATACT TTATTGAATG GATTAACAGA TCAATTAACA  AAATTAAAAA ATAAAAACAG ACTCAGAGTT CATAGTACCG TATTAGAAAA 8100
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 9701 ATAGTTAGTC TGATATTAAG AAACTTCTGG CTGTATAACT TATACATGCA  TGAATCAAAG CAACATCCTT TGGCAGGGAA ACAGTTATTC AAACAACTAA 9800
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10901 ATGAGTGTAA ATTTCTTACA TAGATTATCT GTCAGTAGTA GACCTATGGA  ATTCCCAGCA TCAGTTCCAG CTTATAGAAC AACAAATTAC CATTTCGACA 11000
11001 CTAGTCCTAT TAATCAAGCA CTAAGTGAGA GATTTGGGAA TGAAGATATT  AACTTGGTCT TCCAAAATGC AATCAGCTGT GGAATTAGCA TAATGAGTGT 11100
11101 AGTAGAACAA TTAACAGGTA GAAGCCCAAA ACAGTTAGTT TTAATACCCC  AATTAGAAGA AATAGACATT ATGCCACCAC CAGTGTTTCA AGGGAAATTC 11200
11201 AATTATAAAT TAGTAGATAA GATAACTTCT GATCAACATA TCTTTAGTCC  GGACAAAATA GATATGTTAA CACTAGGGAA AATGCTCATG CCCACTATAA 11300
11301 AAGGTCAGAA AACAGATCAG TTCTTAAATA AGAGAGAAAA TTATTTCCAT  GGAAACAATC TTATTGAGTC TTTATCAGCA GCATTAGCAT GTCATTGGTG 11400
11401 TGGGATATTA ACAGAACAAT GCATAGAAAA TAATATTTTC AAGAAAGACT  GGGGTGACGG GTTTATATCA GATCATGCTT TTATGGACTT CAAAATATTC 11500
11501 CTATGTGTCT TTAAAACTAA ACTTTTATGT AGTTGGGGAT CTCAAGGGAA  AAACATTAAA GATGAAGATA TAGTAGATGA ATCAATAGAT AAATTGTTAA 11600
11601 GGATTGACAA TACTTTTTGG AGAATGTTCA GCAAAGTTAT GTTTGAACCA  AAGGTTAAGA AAAGGATAAT GTTATATGAT GTAAAATTCC TATCACTAGT 11700
11701 AGGCTACATA GGGTTTAAGA ACTGGTTTAT AGAGCAGTTG AGATCAGCTG  AATTGCATGA AATACCTTGG ATTGTCAATG CCGAAGGTGA TTTGGTTGAG 11800
```

Fig. 37C

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 57 of 66 Sheets

HMPV strain 83 (continued)

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11801 ATCAAGTCAA TTAAAATCTA TTTGCAACTG ATAGAACAAA GCTTATTTTT  AAGAATAACT GTTTTGAACT ATACAGATAT GGCACATGCT CTCACACGAT 11900
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12001 TTACTTCCCC AAGATAACAT TCGAAAGGCT AAAAAATTAT GACACAAGTT  CAAATTATGC TAAAGGGAAG CTAACAAGAA ATTACATGAT ACTATTGCCA 12100
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12201 AAGTTTTGTA CTTTATTGGA GAAGGAGCAG GAAATTGGAT GGCCAGAACA  GCATGTGAAT ATCCTGATAT TAAATTTGTA TATAGAAGTC TGAAAGATGA 12300
12301 CCTTGATCAT CATTATCCTC TGGAATACCA GAGAGTGATA GGTGAATTAA  GCAGAATCAT AGATAGTGGT GAAGGACTTT CAATGGAAAC AACAGACGCA 12400
12401 ACTCAAAAAA CTCATTGGGA TTTGATACAC AGGGTAAGCA AAGATGCTTT  ATTAATAACT TTATGTGATG CAGAATTTAA GGACAGAGAT GATTTTTTTA 12500
12501 AGATGGTAAT TCTATGGAGA AAACATGTAT TATCATGCAG AATTTGCACT  ACTTATGGGA CGGACCTCTA TTTATTCGCA AAGTATCATG CTAAAGACTG 12600
12601 CAATGTAAAA TTACCTTTTT TTGTGAGATC AGTTGCTACT TTCATTATGC  AGGGTAGTAA GCTGTCAGGT TCAGAATGCT ACATACTCTT AACACTAGGC 12700
12701 CACCACAACA GTTTACCTTG CCATGGAGAA ATACAAAATT CTAAGATGAA  AATAGCAGTG TGTAATGATT TTTATGCTGC AAAAAAACTC GACAATAAAT 12800
12801 CAATTGAAGC TAATTGTAAA TCACTTTTGT CAGGGCTAAG AATACCTATA  AATAAGAAGG AACTAGATAG ACAGAGAAGA TTATTAACAC TACAAAGCAA 12900
12901 TCATTCTTCT GTAGCAACAG TTGGCGGTAG CAAGATCATA GAGTCTAAGT  GGTTAACAAA CAAAGCAAGT ACAATAATTG ATTGGTTAGA ACATATTTTA 13000
13001 AATTCTCCAA AGGGCGAATT AAATTATGAT TTTTTTGAAG CATTGGAGAA  CACTTACCCT AATATGATTA AACTAATAGA TAACTTAGGG AATGCAGAGA 13100
13101 TTAAAAAACT GATCAAAGTA ACAGGATACA TGCTTGTAAG TAAAAAATGA  AAAATGATGA AGATGACAAA ATAGATGACA ACTTCATACT ATTCTAAATT 13200
13201 AATTATTTGA TTATGCAATT ATATGATAGT TAATTAAAAT TAAAAATTAA  AAATCAAAAG TTAAAATTTA AAACCTATCA TTAAGTTTAT TAAAAATAAG 13300
13301 AAATTATAAT TGAATGTATA CGGTTTTTTT GCCGT                                                                    13335
          |   10      |   20      |   30      |   40      |   50      |   60      |   70      |   80      |   90      |   100
```

Fig. 37D

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 58 of 66 Sheets

rHMPV-GFP

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      |   10      |   20      |   30      |   40      |   50      |   60      |   70      |   80      |   90      |  100
    1 ACGCGAAAAA AACGCGTATA AATTAAGTTA CAAAAAAACA TGGGACAAGT GAAAATGGTG AGCAAGGGCG AGGAGCTGTT CACCGGGGTG GTGCCCATCC  100
  101 TGGTCGAGCT GGACGGCGAC GTAAACGGCC ACAAGTTCAG CGTGTCCGGC GAGGGCGAGG GCGATGCCAC CTACGGCAAG CTGACCCTGA AGTTCATCTG  200
  201 CACCACCGGC AAGCTGCCCG TGCCCTGGCC CACCCTCGTG ACCACCCTGA CCTACGGCGT GCAGTGCTTC AGCCGCTACC CCGACCACAT GAAGCAGCAC  300
  301 GACTTCTTCA AGTCCGCCAT GCCCGAAGGC TACGTCCAGG AGCGCACCAT CTTCTTCAAG GACGACGGCA ACTACAAGAC CCGCGCCGAG GTGAAGTTCG  400
  401 AGGGCGACAC CCTGGTGAAC CGCATCGAGC TGAAGGGCAT CGACTTCAAG GAGGACGGCA ACATCCTGGG GCACAAGCTG GAGTACAACT ACAACAGCCA  500
  501 CAACGTCTAT ATCATGGCCG ACAAGCAGAA GAACGGCATC AAGGTGAACT TCAAGATCCG CCACAACATC GAGGACGGCA GCGTGCAGCT CGCCGACCAC  600
  601 TACCAGCAGA ACACCCCCAT CGGCGACGGC CCCGTGCTGC TGCCCGACAA CCACTACCTG AGCACCCAGT CCGCCCTGAG CAAAGACCCC AACGAGAAGC  700
  701 GCGATCACAT GGTCCTGCTG GAGTTCGTGA CCGCCGCCGG GATCACTCTC GGCATGGACG AGCTGTACAA GTAAGTTAAT TAAAAAAGTG GGACAAGTGA  800
  801 AAATGTCTCT TCAAGGGATT CACCTGAGTG ATCTATCATA CAAGCATGCT ATATTAAAAG AGTCTCAGTA TACAATAAAG AGAGATGTAG GCACAACAAC  900
  901 AGCAGTGACA CCCTCATCAT TGCAACAAGA AATAACACTA TTGTGTGGAG AAATTCTATA TGCTAAGCAT GCTGATTACA AATATGCTGC AGAAATAGGA 1000
 1001 ATACAATATA TTAGCACAGC TCTAGGATCA GAGAGAGTAC AGCAGATTCT AAGAAACTCA GGCAGTGAAG TCCAAGTGGT TTTAACCAGA ACGTACTCCT 1100
 1101 TGGGGAAAGT TAAAAACAAC AAAGGAGAAG ATTTACAGAT GTTAGACATA CACGGAGTAG AGAAAAGCTG GGTGGAAGAG ATAGACAAAG AAGCAAGAAA 1200
 1201 AACAATGGCA ACTTTGCTTA AAGAATCATC AGGCAATATT CCACAAAATC AGAGGCCTTC AGCACCAGAC ACACCTATAA TCTTATTATG TGTAGGTGCC 1300
 1301 TTAATATTTA CCAAACTAGC ATCAACTATA GAAGTGGGAT TAGAGACCAC AGTCAGAAGA GCTAACCGTG TACTAAGTGA TGCACTCAAA AGATACCCTA 1400
 1401 GGATGGACAT ACCAAAAATC GCTAGATCTT TCTATGATTT ATTTGAACAA AAAGTGTATT ACAGAAGTTT GTTCATTGAG TATGGCAAAG CATTAGGCTC 1500
 1501 ATCCTCTACA GGCAGCAAAG CAGAAAGTTT ATTCGTTAAT ATATTCATGC AAGCTTACGG TGCTGGTCAA ACAATGCTGA GGTGGGGAGT CATTGCCAGG 1600
 1601 TCATCTAACA ATATAATGTT AGGACATGTA TCTGTCCAAG CTGAGTTAAA ACAAGTCACA GAAGTCTATG ACCTGGTGCG AGAAATGGGC CCTGAATCTG 1700
 1701 GGCTCCTACA TTTAAGGCAA AGCCCAAAAG CTGGACTGTT ATCACTAGCC AATTGTCCCA ACTTTGCAAG TGTTGTTCTC GGCAATGCCT CAGGCTTAGG 1800
 1801 CATAATAGGT ATGTATCGCG GGAGAGTGCC AAACACAGAA CTATTTTCAG CAGCAGAAAG CTATGCCAAG AGTTTGAAAG AAAGCAATAA AATTAACTTT 1900
 1901 TCTTCATTAG GACTCACAGA TGAAGAAAAA GAGGCTGCAG AACACTTTCT AAATGTGAGT GACGACAGTC AAAATGATTA TGAGTAATTA AAAAAGTGGG 2000
 2001 ACAAGTCAAA ATGTCATTCC CTGAAGGAAA AGATATTCTT TTCATGGGTA ATGAAGCGGC AAAATTGGCA GAAGCTTTCC AAAAATCATT AAGAAAACCT 2100
 2101 AGTCATAAAA GATCTCAATC TATTATAGGA GAAAAAGTGA ACACTGTATC TGAAACATTG GAATTACCTA CTATCAGTAG ACCTACCAAA CCGACCATAT 2200
 2201 TGTCAGAGCC GAAGTTAGCA TGGACAGACA AAGGTGGGGC AATCAAAACT GAAGCAAAGC AAACAATCAA AGTTATGGAT CCTATTGAAG AAGAAGAGTT 2300
 2301 TACTGAGAAA AGGGTGCTGC CCTCCAGTGA TGGGAAAACT CCTGCAGAAA AGAAGTTGAA ACCATCAACC AATACTAAAA AGAAGGTCTC ATTTACACCA 2400
 2401 AATGAACCAG GAAAATACAC AAAGTTGGAG AAAGATGCTC TAGACTTGCT TTCAGACAAT GAAGAAGAAG ATGCAGAATC CTCAATCTTA ACCTTCGAAG 2500
 2501 AAAGAGATAC TTCATCATTA AGCATTGAAG CCAGACTAGA ATCGATTGAG GAGAAATTAA GCATGATATT AGGGCTATTA AGAACACTCA ACATTGCTAC 2600
 2601 AGCAGGACCC ACAGCAGCAA GAGATGGGAT CAGAGATGCA ATGATTGGCA TAAGGGAGGA ACTAATAGCA GACATAATAA AAGAAGCCAA GGGAAAAGCA 2700
 2701 GCAGAAATGA TGGAAGAAGA AATGAACCAG CGGACAAAAA TAGGAAACGG TAGTGTAAAA TTAACTGAAA AGGCAAAGGA GCTCAACAAA ATTGTTGAAG 2800
 2801 ACGAGAGCAC AAGTGGTGAA TCCGAAGAAG AAGAAGAACT AAAAGACACA CAGGAAAATA ATCAAGAAGA TGACATTTAC CAGTTAATTA TGTAGTTTAA 2900
 2901 TAAAAATAAA AAATGGGACA AGTGAAAATG GAGTCCTATC TGGTAGACAC CTATCAAGGC ATCCCTTACA CAGCAGCTGT TCAAGTTGAT CTAGTAGAAA 3000
 3001 AGGACCTGTT ACCTGCAAGC CTAACAATAT GGTTCCCCCT GTTTCAGGCC AATACACCAC CAGCAGTTCT GCTTGATCAG CTAAAGACTC TGACTATAAC 3100
 3101 TACTCTGTAT GCTGCATCAC AAAGTGGTCC AATACTAAAA GTGAATGCAT CGGCCCAGGG TGCAGCAATG TCTGTACTTC CCAAAAAGTT TGAAGTCAAT 3200
 3201 GCGACTGTAG CACTTGACGA ATATAGCAAA TTAGAATTTG ACAAACTTAC AGTCTGTGAA GTAAAAACAG TTTACTTAAC AACCATGAAA CCATATGGGA 3300
 3301 TGGTATCAAA GTTTGTGAGC TCGGCCAAAC CAGTTGGCAA AAAAACACAT GATCTAATCG CATTATGCGA TTTTATGGAT CTAGAAAAGA ACACACCAGT 3400
 3401 TACAATACCA GCATTTATCA AATCAGTTTC TATCAAGGAG AGTGAATCAG CCACTGTTGA AGCTGCAATA AGCAGTGAAG CAGACCAAGC TCTAACACAA 3500
 3501 GCCAAAATTG CACCTTATGC GGGACTGATC ATGATTATGA CCATGAACAA TCCCAAAGGC ATATTCAAGA AGCTTGGAGC TGGGACCCAA GTTATAGTAG 3600
 3601 AACTAGGAGC ATATGTCCAG GCTGAAAGCA TAAGTAAAAT ATGCAAGACT TGGAGCCATC AAGGAACAAG ATATGTGCTG AAGTCCAGAT AACAGCCAAG 3700
 3701 CAACCTGACC AAGAACTACC AACTCTATTC TATAGACTAA AAAGTCGCCA TTTTAGTTAT ATAAAAATCA AGTTAGAATA AGAATGCTAG CAATCAAGAA 3800
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Fig. 38A

rHMPV-GFP (continued)

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3801 CGGGACAAAT AAAAATGTCT TGGAAAGTGG TGATCATTTT TTCATTGCTA  ATAACACCTC AACACGGTCT TAAAGAGAGC TACCTAGAAG AATCATGTAG 3900
3901 CACTATAACT GAGGGATATC TTAGTGTTCT GAGGACAGGT TGGTATACCA  ACGTTTTTAC ATTAGAGGTG GGTGATGTAG AAAACCTTAC ATGTTCTGAT 4000
4001 GGACCTAGCC TAATAAAAAC AGAATTAGAT CTGACCAAAA GTGCACTAAG  AGAGCTCAAA ACAGTCTCTG CTGACCAATT GGCAAGAGAG GAACAAATTG 4100
4101 AGAATCCCAG ACAATCTAGG TTTGTTCTAG GAGCAATAGC ACTCGGTGTT  GCAACAGCAG CTGCAGTCAC AGCAGGTGTT GCAATTGCCA AAACCATCCG 4200
4201 GCTTGAGAGT GAAGTCACAG CAATTAAGAA TGCCCTCAAA ACGACCAATG  AAGCAGTATC TACATTGGGG AATGGAGTTC GAGTGTTGGC AACTGCAGTG 4300
4301 AGAGAGCTGA AAGACTTTGT GAGCAAGAAT TTAACTCGTG CAATCAACAA  AAACAAGTGC GACATTGATG ACCTAAAAAT GGCCGTTAGC TTCAGTCAAT 4400
4401 TCAACAGAAG GTTTCTAAAT GTTGTGCGGC AATTTTCAGA CAATGCTGGA  ATAACACCAG CAATATCTTT GGACTTAATG ACAGATGCTG AACTAGCCAG 4500
4501 GGCCGTTTCT AACATGCCGA CATCTGCAGG ACAAATAAAA TTGATGTTGG  AGAACCGTGC GATGGTGCGA AGAAAGGGGT TCGGAATCCT GATAGGGGTC 4600
4601 TACGGGAGCT CCGTAATTTA CATGGTGCAG CTGCCAATCT TTGGCGTTAT  AGACACGCCT TGCTGGATAG TAAAAGCAGC CCCTTCTTGT TCCGGAAAAA 4700
4701 AGGGAAACTA TGCTTGCCTC TTAAGAGAAG ACCAAGGGTG GTATTGTCAG  AATGCAGGGT CAACTGTTTA CTACCCAAAT GAGAAAGACT GTGAAACAAG 4800
4801 AGGAGACCAT GTCTTTTGCG ACACAGCAGC GGGAATTAAT GTTGCTGAGC  AATCAAAGGA GTGCAACATC AACATATCCA CTACAAATTA CCCATGCAAA 4900
4901 GTCAGCACAG GAAGACATCC TATCAGTATG GTTGCACTGT CTCCTCTTGG  GGCTCTGGTT GCTTGCTACA AAGGAGTAAG CTGTTCCATT GGCAGCAACA 5000
5001 GAGTAGGGAT CATCAAGCAG CTGAACAAGG GTTGCTCCTA TATAACCAAC  CAAGATGCAG ACACAGTGAC AATAGACAAC ACTGTATATC AGCTAAGCAA 5100
5101 AGTTGAGGGT GAACAGCATG TTATAAAAGG CAGACCAGTG TCAAGCAGCT  TTGATCCAAT CAAGTTTCCT GAAGATCAAT TCAATGTTGC ACTTGACCAA 5200
5201 GTTTTTGAGA ACATTGAAAA CAGCCAGGCC TTGGTAGATC AATCAAACAG  AATCCTAAGC AGTGCAGAGA AAGGGAATAC TGGCTTCATC ATTGTAATAA 5300
5301 TTCTAATTGC TGTCCTTGGC TCTAGCATGA TCCTAGTGAG CATCTTCATT  ATAATCAAGA AAACAAAGAA ACCAACGGGA GCACCTCCAG AGCTGAGTGG 5400
5401 TGTCACAAAC AATGGCTTCA TACCACACAG TTAGTTAATT AAAAATAAAA  TAAAATTTGG GACAAATCAT AATGTCTCGC AAGGCTCCAT GCAAATATGA 5500
5501 AGTGCGGGGC AAATGCAACA GAGGAAGTGA GTGTAAGTTT AACCACAATT  ACTGGAGTTG GCCAGATAGA TACTTATTAA TAAGATCAAA CTATCTATTA 5600
5601 AATCAGCTTT TAAGGAACAC TGATAGAGCT GATGGCCTAT CAATAATATC  AGGCGCAGGC AGAGAAGACA GAACGCAAGA TTTTGTTCTA GGTTCCACCA 5700
5701 ATGTGGTTCA AGGTTATATT GATGATAACC AAAGCATAAC AAAAGCTGCA  GCCTGCTACA GTCTACACAA CATAATCAAG CAACTACAAG AAGTTGAAGT 5800
5801 TAGGCAGGCT AGAGATAGCA AACTATCTGA CAGCAAGCAT GTGGCACTCC  ATAACTTAAT CTTATCTTAC ATGGAGATGA GCAAAACTCC CGCATCTTTA 5900
5901 ATCAACAATC TCAAAAGACT GCCGAGAGAA AAACTGAAAA AATTAGCAAA  GCTGATAATT GACTTATCAG CAGGCGCTGA CAATGACTCT TCATATGCCC 6000
6001 TGCAAGACAG TGAAAGCATT AATCAAGTGC AGTGAGCATG GTCCTGTTTT  CATTACTATA GAGGTTGATG AAATGATATG GACTCAAAAA GAATTAAAAG 6100
6101 AAGCTTTGTC CGATGGGATA GTGAAGTCTC ACACCAACAT TTACAATTGT  TATTTAGAAA ACATAGAAAT TATATATGTC AAGGCTTACT TAAGTTAGTA 6200
6201 AAAACACATC AGAGTGGGAT AAGTGACAAT GATAACATTA GATGTCATTA  AAAGTGATGG GTCTTCAAAA ACATGTACTC ACCTCAAAAA AATAATCAAA 6300
6301 GACCATTCTG GTAAAGTGCT TATTGCACTT AAGTTAATAT TAGCTTTACT  AACATTTTTC ACAATAACAA TCACTATAAA TTACATAAAA GTAGAAAACA 6400
6401 ATCTACAAAT ATGCCAGTCA AAAACTGAAT CAGACAAAGA AGACTCACCA  TCAAATACCA CATCCGTCAC AACCAAGACC ACTCTAGACC ATGATATAAC 6500
6501 ACAGTATTTT AAAAGATTAA TTCAAAGGTA TACAGATTCT GTAATAAACA  AGGACACATG CTGGAAAATA AGCAGAAATC AATGCACAAA TATAACAACA 6600
6601 TATAAATTTT TATGCTTTAA ACCTGAGGAC TCAAAAATCA ACAGTTGTGA  TAGACTGACA GATCTATGCA GAAACAAATC AAAATCAGCA GCTGAAGCAT 6700
6701 ATCATACAGT AGAATGCCAT TGCATATACA CAATTGAGTG GAAGTGCTAT  CACCACTCAA TAGATTAAAC CCAATCTTGA ATGTTAAAAC TAGACTAGGA 6800
6801 TCCGTCTAAG ACTATCAGTT CAATAGTTTA GTTATTTTAA AATATTTGAG  AATAGGTAAG TTTCTATGGC ACTTCATAGC AATAGGTAAT AATTAACAGC 6900
6901 TTAATTATAA TTAAAACATT ATTTAAAATC GTAACTATTT AATTTACAAA  GTAAAAACAA AAATATGGGA CAAGTAGTTA TGGAGGTGAA AGTAGAGAAC 7000
7001 ATTCGAGCAA TAGACATGCT CAAAGCAAGA GTGAAAAATC GTGTGGCACG  TAGCAAATGC TTTAAAAATG CTTCTTTAAT CCTCATAGGA ATAACTACAC 7100
7101 TGAGTATAGC TCTCAATATC TATCTGATCA TAAACTACAC AATACAAAAA  ACCTCATCTG AATCAGAACA CCACACCAGC TCACCACCCA CAGAATCCAA 7200
7201 CAAGGAAGCT TCAACAATCT CCACAGACAA CCCAGACATC AATCCAAACT  CACAGCATCC AACTCAACAG TCCACAGAAA ACCCCACACT CAACCCCGCA 7300
7301 GCATCAGTGA GCCCATCAGA AACAGAACCA GCATCAACAC CAGACACAAC  AAACCGCCTG TCCTCCGTAG ACAGGTCCAC AGCACAACCA AGTGAAAGCA 7400
7401 GAACAAAGAC AAAACCGACA GTCCACACAA GAAACAACCC AAGCACAGCT  TCCAGTACAC AATCCCCACC ACGGGCAACA ACGAAGGCAA TCCGCAGAGC 7500
7501 CACCACTTTC CGCATGAGCA GCACAGGAAA AAGACCAACC ACAACATCAG  TCCAGTCCGA CAGCAGCACC ACAACCCAAA ATCATGAAGA AACAGGTTCA 7600
7601 GCGAACCCAC AGGCATCTGT AAGCACAATG CAAAACTAGC ACACCAACAA  TATAAAACCA AATTAGTTAA CAAAAAATAC GAGATAGCTC TAAAGTAAAA 7700
7701 CATGTAGGTA CCAACAATCA AGAAACCAAA AGACAACTCA CAATCTCCCT  AAAACAGCAA CGACACCATG TCAGCTTTGC TCAAATCTCT CTGGGAGAAA 7800
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Fig. 38B

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 60 of 66 Sheets

rHMPV-GFP (continued)

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 7801 CTTTTGCCCA CATACTAACA ACATCACAAC CATCTCAAGA AAAGAAACTG  GGCAAAACAG CATCCAAGAG ACAAATAGCA ATGGATCCTC TTAATGAATC 7900
 7901 CACTGTTAAT GTCTATCTCC CTGATTCGTA CCTTAAAGGA GTAATTTCTT  TTAGTGAAAC TAATGCAATT GGTTCATGTC TCTTAAAAAG ACCCTACTTA 8000
 8001 AAAAATGACA ACACTGCAAA AGTTGCCATA GAGAATCCTG TTATTGAGCA  TGTGAGACTC AAAAATGCAG TCAATTCTAA AATGAAAATA TCAGATTACA 8100
 8101 AGGTAGTAGA GCCAGTAAAC ATGCAACATG AAATAATGAA GAATGTACAC  AGTTGTGAGC TCACACTATT GAAACAGTTT TTAACAAGGA GTAAAAACAT 8200
 8201 TAGCACTCTC AAATTGAATA TGATATGTGA TTGGCTGCAA TTAAAGTCTA  CATCAGATGA TACCTCAATC CTAAGTTTCA TAGATGTAGA ATTTATACCT 8300
 8301 AGTTGGGTAA GCAACTGGTT TAGTAATTGG TACAATCTCA ATAAGTTAAT  TTTGGAATTC AGAAGAGAGG AAGTAATAAG AACCGGTTCA ATCTTATGCA 8400
 8401 GGTCATTGGG TAAATTAGTT TTTATTGTAT CATCATATGG ATGTATCGTC  AAGAGCAACA AAAGCAAAAG AGTGAGCTTC TTCACATACA ATCAACTGTT 8500
 8501 AACATGGAAA GATGTGATGT TAAGTAGATT TAATGCGAAT TTTTGTATAT  GGGTAAGCAA TAGTCTGAAT GAAAATCAGG AAGGGCTAGG GTTGAGAAGT 8600
 8601 AATCTGCAAG GTATGTTAAC TAATAAACTA TATGAAACTG TAGATTATAT  GCTAAGCTTA TGTTGCAATG AAGGTTTCTC ACTTGTGAAA GAGTTCGAAG 8700
 8701 GTTTTATTAT GAGTGAGATC CTTAGGATTA CTGAACATGC TCAATTCAGT  ACTAGATTTA GAAATACTTT ATTGAATGGA TTAACAGATC AATTAACAAA 8800
 8801 ATTAAAAAAT AAAAACAGAC TCAGAGTTCA TAGTACCGTA TTAGAAAATA  ATGATTATCC AATGTATGAA GTTGTACTTA AATTATTAGG AGATACTTTG 8900
 8901 AGATGTATCA AATTATTAAT CAATAAAAAC TTAGAGAATG CTGCAGAATT  ATACTATATA TTCAGAATTT TTGGTCATCC AATGGTAGAT GAAAGAGATG 9000
 9001 CAATGGATGC TGTCAAATTA AACAATGAAA TCACAAAAAT CCTAAGGTTG  GAGAGCTTGA CAGAACTAAG AGGGGCATTC ATATTAAGGA TTATCAAAGG 9100
 9101 ATTTGTGGAC AACAACAAAA GGTGGCCCAA AATTAAAAAC TTAAAAGTGC  TTAGCAAAAG ATGGACTATG TACTTCAAAG CTAAAAATTA CCCCAGTCAA 9200
 9201 CTCGAATTAA GTGAACAAGA CTTTCTAGAG CTTGCTGCAA TACAATTTGA  ACAAGAGTTT TCTGTTCCTG AAAAAACCAA TCTTGAGATG GTATTAAATG 9300
 9301 ACAAAGCCAT ATCACCTCCT AAAAGATTAA TATGGTCTGT GTATCCAAAG  AATTACTTAC CTGAGACGAT AAAAAATCGA TATTTAGAAG AAACTTTCAA 9400
 9401 TGCGAGTGAT AGTCTCAAAA CAAGAAGAGT ACTAGAGTAC TATTTAAAAG  ATAATAAATT TGATCAAAAG GAACTTAAAA GTTATGTAGT TAGACAAGAA 9500
 9501 TATTTAAACG ATAAGGAGCA CATTGTCTCA TTAACTGGAA AAGAAAGAGA  ATTAAGTGTA GGTAGAATGT TTGCTATGCA ACCAGGAAAA CAGCGACAAA 9600
 9601 TACAAATATT GGCAGAAAAA TTGTTAGCTG ATAACATTGT ACCTTTCTTC  CCGGAAACCT TAACAAAGTA TGGTGATCTA GATCTTCAGA GAATAATGGA 9700
 9701 AATCAAATCA GAACTTTCTT CTATCAAAAC CAGAAGAAAT GATAGTTATA  ATAATTACAT TGCAAGAGCA TCCATAGTAA CAGATTTGAG CAAGTTCAAC 9800
 9801 CAAGCCTTTA GATATGAAAC TACAGCGATC TGTGCGGATG TAGCAGACGA  ATTACATGGA ACACAAAGCT TATTCTGTTG GTTACATCTT ATCGTTCCTA 9900
 9901 TGACTACAAT GATATGTGCC TATAGACATG CACCACCAGA AACAAAAGGT  GAATATGATA TAGATAAGAT AGAAGAGCAA AGTGGTCTAT ATAGATATCA 10000
10001 CATGGGCGGT ATTGAAGGAT GGTGTCAAAA ACTCTGGACA ATGGAAGCTA  TATCTTTATT GGATGTTGTA TCTGTAAAGA CACGGTGTCA AATGACATCT 10100
10101 TTATTAAACG GTGACAACCA ATCAATAGAT GTAAGTAAAC CAGTCAAGTT  ATCTGAAGGT TTAGATGAAG TGAAGGCAGA TTATCGCTTA GCAGTAAAAA 10200
10201 TGCTAAAAGA AATAAGAGAT GCATACAGAA ATATAGGCCA TAAACTTAAA  GAAGGGGAAA CATATATATC AAGGGATCTT CAGTTTATAA GCAAGGTGAT 10300
10301 TCAATCTGAA GGAGTGATGC ATCCTACCCC TATAAAAAAG GTCTTGAGAG  TAGGACCATG GATAAACACA ATATTAGATG ACATTAAAAC TAGTGCTGAG 10400
10401 TCAATAGGGA GTCTATGTCA AGAATTAGAA TTTAGGGGAG AAAGCATAAT  AGTTAGTCTG ATATTAAGAA ACTTCTGGCT GTATAACTTA TACATGCATG 10500
10501 AATCAAAGCA ACATCCTTTG GCAGGGAAAC AGTTATTCAA ACAACTAAAT  AAAACATTAA CATCAGTGCA GAGATTTTTT GAAATTAAAA GGGAAAATGA 10600
10601 GGTAGTAGAT CTATGGATGA ACATACCAAT GCAATTTGGA GGAGGAGATC  CAGTAGTCTT CTATAGATCT TTCTATAGAA GGACCCCTGA TTTTTTAACT 10700
10701 GAGGCAATCA GCCATGTAGA TATTCTGTTA AAAATATCAG CTAACATAAA  AAATGAAACG AAAGTAAGTT TCTTCAAAGC CTTACTATCA ATAGAAAAAA 10800
10801 ATGAACGTGC TACACTGACA ACACTAATGA GAGATCCTCA AGCTGTTGGA  TCAGAACGAC AAGCAAAAGT AACAAGTGAC ATCAATAGAA CAGCAGTTAC 10900
10901 CAGTATCTTA AGTCTTTCCC CAAATCAACT TTTCAGTGAT AGTGCTATAC  ACTACAGCAG AAATGAAGAA GAAGTGGGAA TCATTGCAGA AAACATAACA 11000
11001 CCTGTTTATC CTCATGGGCT GAGAGTATTA TATGAATCAT TGCCCTTTCA  CAAAGCTGAA AAAGTTGTAA ACATGATATC AGGGACAAAA TCTATAACCA 11100
11101 ACTTATTACA GAGAACATCC GCTATTAATG GTGAAGATAT TGACAGGGCT  GTATCTATGA TGTTGGAGAA TCTAGGATTA TTATCTAGAA TATTGTCAGT 11200
11201 AGTTGTTGAT AGTATAGAAA TTCCAATCAA ATCTAATGGT AGGCTGATAT  GTTGTCAAAT CTCTAGGACT TTAAGAGAGA CATCATGGAA TAATATGGAA 11300
11301 ATAGTTGGAG TAACATCTCC TAGCATCACT ACATGTATGG ATGTCATATA  TGCAACTAGT TCTCATTTGA AAGGGATAAT TATAGAAAAG TTCAGCACTG 11400
11401 ACAGAACTAC AAGGGGTCAA AGAGGTCCAA AAAGCCCTTG GGTAGGGTCG  AGTACTCAAG AGAAAAAATT AGTACCTGTT TATAACAGAC AAATTCTCTC 11500
11501 AAAACAACAA AGAGAACAGC TAGAAGCAAT TGGAAAAATG AGATGGGTGT  ATAAAGGGAC ACCAGGCTTG CGACGATTAC TCAACAAGAT CTGTCTTGGG 11600
11601 AGTTTAGGCA TTAGCTACAA ATGTGTAAAA CCTTTATTAC CTAGGTTTAT  GAGTGTAAAT TTCTTACATA GATTATCTGT CAGTAGTAGA CCTATGGAAT 11700
11701 TCCCAGCATC AGTTCCAGCT TATAGAACAA CAAATTACCA TTTCGACACT  AGTCCTATTA ATCAAGCACT AAGTGAGAGA TTTGGGAATG AAGATATTAA 11800
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Fig. 38C

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 61 of 66 Sheets

rHMPV-GFP (continued)

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11801 CTTGGTCTTC CAAAATGCAA TCAGCTGTGG AATTAGCATA ATGAGTGTAG  TAGAACAATT AACAGGTAGA AGCCCAAAAC AGTTAGTTTT AATACCCCAA 11900
11901 TTAGAAGAAA TAGACATTAT GCCACCACCA GTGTTTCAAG GGAAATTCAA  TTATAAATTA GTAGATAAGA TAACTTCTGA TCAACATATC TTTAGTCCGG 12000
12001 ACAAAATAGA TATGTTAACA CTAGGGAAAA TGCTCATGCC CACTATAAAA  GGTCAGAAAA CAGATCAGTT CTTAAATAAG AGAGAAAATT ATTTCCATGG 12100
12101 AAACAATCTT ATTGAGTCTT TATCAGCAGC ATTAGCATGT CATTGGTGTG  GGATATTAAC AGAACAATGC ATAGAAAATA ATATTTTCAA GAAAGACTGG 12200
12201 GGTGACGGGT TTATATCAGA TCATGCTTTT ATGGACTTCA AAATATTCCT  ATGTGTCTTT AAAACTAAAC TTTTATGTAG TTGGGGATCT CAAGGGAAAA 12300
12301 ACATTAAAGA TGAAGATATA GTAGATGAAT CAATAGATAA ATTGTTAAGG  ATTGACAATA CTTTTTGGAG AATGTTCAGC AAAGTTATGT TTGAACCAAA 12400
12401 GGTTAAGAAA AGGATAATGT TATATGATGT AAAATTCCTA TCACTAGTAG  GCTACATAGG GTTTAAGAAC TGGTTTATAG AGCAGTTGAG ATCAGCTGAA 12500
12501 TTGCATGAAA TACCTTGGAT TGTCAATGCC GAAGGTGATT TGGTTGAGAT  CAAGTCAATT AAAATCTATT TGCAACTGAT AGAACAAAGC TTATTTTTAA 12600
12601 GAATAACTGT TTTGAACTAT ACAGATATGG CACATGCTCT CACACGATTA  ATCAGAAAGA AGTTAATGTG TGATAATGCA CTGTTAACCC CAATTTCATC 12700
12701 CCCAATGGTT AACTTAACTC AAGTTATTGA TCCCACAACA CAATTAGATT  ACTTCCCCAA GATAACATTC GAAAGGCTAA AAAATTATGA CACAAGTTCA 12800
12801 AATTATGCTA AAGGGAAGCT AACAAGAAAT TACATGATAC TATTGCCATG  GCAGCATGTT AATAGATATA ACTTTGTCTT TAGTTCTACT GGATGTAAAG 12900
12901 TTAGTCTGAA AACATGTATT GGAAAACTTA TGAAAGACCT AAATCCTAAA  GTTTTGTACT TTATTGGAGA AGGAGCAGGA AATTGGATGG CCAGAACAGC 13000
13001 ATGTGAATAT CCTGATATTA AATTTGTATA TAGAAGTCTG AAAGATGACC  TTGATCATCA TTATCCTCTG GAATACCAGA GAGTGATAGG TGAATTAAGC 13100
13101 AGAATCATAG ATAGTGGTGA AGGACTTTCA ATGGAAACAA CAGACGCAAC  TCAAAAAACT CATTGGGATT TGATACACAG GGTAAGCAAA GATGCTTTAT 13200
13201 TAATAACTTT ATGTGATGCA GAATTTAAGG ACAGAGATGA TTTTTTTAAG  ATGGTAATTC TATGGAGAAA ACATGTATTA TCATGCAGAA TTTGCACTAC 13300
13301 TTATGGGACG GACCTCTATT TATTCGCAAA GTATCATGCT AAAGACTGCA  ATGTAAAATT ACCTTTTTTT GTGAGATCAG TTGCTACTTT CATTATGCAG 13400
13401 GGTAGTAAGC TGTCAGGTTC AGAATGCTAC ATACTCTTAA CACTAGGCCA  CCACAACAGT TTACCTTGCC ATGGAGAAAT ACAAAATTCT AAGATGAAAA 13500
13501 TAGCAGTGTG TAATGATTTT TATGCTGCAA AAAAACTCGA CAATAAATCA  ATTGAAGCTA ATTGTAAATC ACTTTTGTCA GGGCTAAGAA TACCTATAAA 13600
13601 TAAGAAGGAA CTAGATAGAC AGAGAAGATT ATTAACACTA CAAAGCAATC  ATTCTTCTGT AGCAACAGTT GGCGGTAGCA AGATCATAGA GTCTAAGTGG 13700
13701 TTAACAAACA AAGCAAGTAC AATAATTGAT TGGTTAGAAC ATATTTTAAA  TTCTCCAAAG GGCGAATTAA ATTATGATTT TTTTGAAGCA TTGGAGAACA 13800
13801 CTTACCCTAA TATGATTAAA CTAATAGATA ACTTAGGGAA TGCAGAGATT  AAAAAACTGA TCAAAGTAAC AGGATACATG CTTGTAAGTA AAAAATGAAA 13900
13901 AATGATGAAG ATGACAAAAT AGATGACAAC TTCATACTAT TCTAAATTAA  TTATTTGATT ATGCAATTAT ATGATAGTTA ATTAAAATTA AAAATTAAAA 14000
14001 ATCAAAAGTT AAAATTTAAA ACCTATCATT AAGTTTATTA AAAATAAGAA  ATTATAATTG AATGTATACG GTTTTTTTGC CGT                    14083
        |  10     |  20     |  30     |  40     |  50     |  60     |  70     |  80     |  90     | 100
```

Fig. 38D

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 62 of 66 Sheets

HMPV strain 75

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      |   10      |   20      |   30      |   40      |   50      |   60      |   70      |   80      |   90      |  100
    1 ACGCGAAAAA AACGCGTATA AATTAAATTC CAAACAAAAC GGGACAAATA AAAATGTCTC TTCAAGGGAT TCACCTAAGT GATCTGTCAT ATAAACATGC 100
  101 TATATTAAAA GAGTCTCAAT ACACAATAAA AAGAGATGTA GGCACCACAA CTGCAGTGAC ACCTTCATCA TTGCAGCAAG AGATAACACT TTTGTGTGGA 200
  201 GAGATTCTTT ACACTAAACA TACTGATTAC AAATATGCTG CAGAGATAGG GATACAATAT ATTTGCACGG CTCTAGGATC AGAAAGAGTA CAACAGATTT 300
  301 TAAGAAATTC AGGCAGTGAA GTTCAGGTGG TTCTAACCAA GACATACTCT TTAGGGAAAG GTAAAAATAG TAAAGGGGAA GAGTTGCAAA TGTTAGATAT 400
  401 ACATGGAGTG GAAAAGAGTT GGGTAGAAGA AATAGACAAA GAGGCAAGAA AAACAATGGT GACTTTGCTA AAGGAATCAT CAGGTAACAT CCCACAAAAC 500
  501 CAGAGGCCTT CAGCACCAGA CACACCAATA ATTTTATTAT GTGTAGGTGC TTTAATATTC ACTAAACTAG CATCAACAAT AGAAGTTGGA CTAGAGACTA 600
  601 CAGTTAGAAG AGCTAACAGA GTGCTAAGTG ATGCGCTCAA AAGATACCCT AGGGTAGATA TACCGAAGAT TGCTAGATCT TTCTATGAAC TATTTGAGCA 700
  701 GAAAGTGTAT TACAGGAGTC TATTCATTGA GTATGGGAAA GCTTTAGGCT CATCTTCAAC AGGAAGCAAA GCAGAAAGTT TGTTTGTAAA TATATTTATG 800
  801 CAAGCTTATG GAGCCGGTCA AACAATGCTA AGGTGGGGTG TCATTGCCAG ATCATCTAAC AACATAATGC TAGGACATGT GTCTGTGCAA GCTGAATTGA 900
  901 AGCAAGTTAC AGAGGTTTAT GATTTGGTGA GAGAAATGGG TCCTGAATCT GGGCTTTTAC ATCTAAGACA AAGTCCAAAG GCAGGACTGT TATCGTTGGC 1000
 1001 CAATTGCCCC GATTTTGCTA GTGTTGTTCT TGGTAATGCT TCAGGTCTAG GTATAATCGG AATGTACAGA GGAAGAGTGC CAAACACAGA GCTATTTTCT 1100
 1101 GCAGCAGAAA GTTATGCCAG AAGCTTAAAA GAAAGCAACA AAATCAACTT CTCCTCATTA GGGCTCACAG ACGAAGAAAA AGAAGCTGCA GAACACTTCT 1200
 1201 TAAACATGAG TGATGACAAT CAAGATGATT ATGAGTAATT AAAAAACTGG GACAAGTCAA AATGTCATTC CCTGAAGGAA AAGATATCCT GTTCATGGGT 1300
 1301 AATGAAGCAG CAAAAATAGC AGAAGCTTTC CAGAAATCAC TAAAAAGATC AGGTCACAAA AGAACCCAGT CTATTGTAGG GGAAAAAGTA AACACTATAT 1400
 1401 CAGAAACTCT AGAGCTACCT ACCATCAGCA AACCTGCACG ATCATCTACA CTGCTAGAGC CAAAATTGGC ATGGGCAGAC AGCAGCAGAG CCACCAAAAC 1500
 1501 CACAGAAAAA CAAACAACCA AAACAACAGA TCCTGTTGAA GAAGAGGAAC TCAATGAAAA GAAGATATCA CCTTCCAGTG ATGGGAAGAC TCCCGCAGAG 1600
 1601 AAAAAATCAA AATCTCCAAC CAATGTAAAA AAGAAAGTTT CCTTCACATC AAATGAACCA GGGAAATATA CCAAACTAGA AAAAGATGCC CTAGATTTGC 1700
 1701 TCTCAGACAA TGAGGAAGAA GACGCAGAGT CCTCAATCTT AACCTTTGAA GAGAGAGACA CATCATCACT AAGCATTGAG GCTAGACTAG AATCAATAGA 1800
 1801 AGAGAAGCTA AGCATGATAT TAGGACTGCT TCGTACACTT AACATTGCAA CAGCAGGACC AACGGCTGCA AGAGATGGAA TCAGAGATGC AATGATTGGT 1900
 1901 ATAAGAGAAG AACTAATAGC AGAAATAATA AAAGAAGCAA AGGGAAAAGC AGCTGAAATG ATGGAAGAGG AAATGAATCA AAGGTCAAAA ATAGGTAATG 2000
 2001 GCAGTGTAAA ACTAACCGAG AAGGCAAAAG AACTTAATAA AATTGTTGAA GACGAGAGCA CAAGCGGTGA ATCAGAAGAA GAAGAAGAAC CAAAAGAAAC 2100
 2101 TCAGGATAAC AATCAAGGAG AAGATATTTA CCAGTTAATC ATGTAGTTTA ATAAAAATAA ACAATGGGAC AAGTCAAGAT GGAGTCCTAT CTAGTGGACA 2200
 2201 CTTATCAAGG CATTCCCTAC ACAGCTGCTG TTCAAGTTGA TCTGGTAGAA AAAGACTTAC TACCAGCAAG TTTGACAATA TGGTTTCCTC TATTCCAAGC 2300
 2301 CAACACACCA CCAGCGGTTT TGCTCGATCA GCTAAAGACC TTGACAATAA CAACTCTGTA TGCTGCATCA CAGAATGGTC CAATACTCAA GGTAAATGCA 2400
 2401 TCAGCTCAGG GTGCTGCTAT GTCTGTACTT CCCAAAAAAT TCGAAGTAAA TGCAACTGTG GCACTTGATG AATACAGCAA ACTTGACTTT GACAAGTTAA 2500
 2501 CGGTTTGCGA TGTTAAAACA GTTTATTTGA CAACCATGAA ACCATATGGG ATGGTGTCAA AATTTGTGAG TTCAGCCAAA TCAGTTGGCA ACAAGACACA 2600
 2601 TGATCTAATT GCACTGTGTG ACTTCATGGA CCTAGAGAAA AATATACCTG TGACAATACC AGCATTCATA AAGTCAGTTT CAATCAAAGA GAGTGAGTCA 2700
 2701 GCCACTGTTG AAGCTGCAAT AAGCAGTGAG GCCGACCAAG CATTAACACA AGCCAAAATT GCACCCTATG CAGGACTAAT CATGATCATG ACCATGAACA 2800
 2801 ATCCAAAAGG TATATTCAAG AAACTAGGAG CTGGAACACA AGTGATAGTA GAGCTAGGGG CATATGTTCA AGCCGAGAGC ATCAGCAGGA TCTGCAAGAG 2900
 2901 CTGGAGTCAC CAAGGAACAA GATATGTACT AAAATCCAGA TAAAAATAAC TGTCCTAATC AATAATTGCT TATATAATCT TAAAGATCAA TGAGCTTATT 3000
 3001 ATTATAGTTA TATAAAAAAA TTTAGAACTA GGAAGGTATT AATAGAAAGC GGGACAAGTA AAAATGTCTT GGAAAGTGAT GATTATCATT TCGTTACTCA 3100
 3101 TAACACCTCA GCACGGACTA AAGGAAAGTT ATTTAGAAGA ATCATGTAGT ACTATAACTG AAGGATATCT CAGTGTTTTA AGAACAGGTT GGTACACCAA 3200
 3201 TGTCTTTACA TTAGAAGTTG GTGATGTTGA AAATCTTACA TGTACTGATG GACCTAGCTT AATCAAAACA GAACTTGACC TAACCAAAAG TGCTCTAAGA 3300
 3301 GAACTCAAAA CAGTTTCTGC TGATCAGTTA GCGAGAGAAG AACAAATTGA AAATCCCAGA CAATCAAGGT TTGTCCTAGG TGCAATAGCT CTTGGTGTTG 3400
 3401 CCACAGCAGC AGCAGTCACA GCAGGCATTG CGATAGCCAA AACCATAAGG CTTGAGAGTG AAGTGAATGC AATCAAAGGT GCTCTCAAAA CAACCAATGA 3500
 3501 GGCAGTATCC ACACTAGGAA ATGGAGTGCG AGTCCTAGCC ACCGCAGTAA GAGAGCTGAA AGAATTTGTG AGCAAAAACC TGACTAGTGC AATTAACAAG 3600
 3601 AACAAATGTG ACATTGCTGA TCTGAAGATG GCTGTCAGCT TCAGTCAATT CAACAGAAGA TTCCTAAATG TTGTGCGGCA GTTTTCAGAC AATGCAGGGA 3700
 3701 TAACACCAGC AATATCATTG GACCTAATGA CTGATGCTGA GCTGGCCAGA GCTGTATCAT ACATGCCAAC ATCTGCAGGA CAGATAAAAC TAATGTTAGA 3800
```

Fig. 39A

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 63 of 66 Sheets

HMPV strain 75 (continued)

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3801 GAACCGTGCA ATGGTGAGGA GAAAAGGATT TGGAATCTTG ATAGGGGTCT  ACGGAAGCTC CGTGATTTAC ATGGTCCAGC TGCCGATCTT TGGTGTCATA 3900
3901 GATACACCTT GTTGGATAAT CAAGGCAGCT CCCTCTTGTT CAGAAAAAGA  TGGAAACTAT GCTTGCCTCC TAAGAGAGGA TCAAGGGTGG TATTGTAAAA 4000
4001 ATGCAGGATC CACTGTTTAC TACCCAAATA AAAAAGACTG CGAAACAAGA  GGTGATCATG TTTTTTGTGA CACAGCTGCA GGGATCAATG TTGCTGAGCA 4100
4101 ATCAAGAGAA TGCAACATCA ACATATCTAC AACCAACTAC CCATGCAAAG  TCAGCACAGG AAGACACCCT ATCAGCATGG TTGCACTATC ACCTCTCGGT 4200
4201 GCTTTGGTGG CTTGCTACAA AGGGGTTAGC TGTTCAATTG GCAGTAATCG  GGTTGGAATA ATCAAACAAC TACCTAAAGG CTGCTCATAC ATAACTAACC 4300
4301 AGGACGCAGA CACTGTAACA ATTGACAACA CTGTGTATCA ACTAAGCAAA  GTTGAGGGTG AACAGCATGT AATAAAAGGG AGACCAGTTT CAAGCAGTTT 4400
4401 CGATCCAATC AAGTTTCCTG AGGATCAGTT CAATGTTGCG CTTGATCAAG  TCTTTGAAAG CATTGAAAAC AGTCAAGCAC TAGTGGACCA GTCAAACAAA 4500
4501 ATTCTGAACA GTGCAGAAAA AGGAAACACT GGCTTCATTA TTGTAATAAT  TTTGATTGCT GTTCTTGGGT TAACCATGAT TTCAGTGAGC ATCATCATCA 4600
4601 TAATCAAAAA AACAAGGAAA CCCACAGGGG CACCTCCAGA GCTGAATGGT  GTTACCAACG GCGGTTTTAT ACCGCATAGT TAGTTAATTA AAAAATGGGA 4700
4701 CAAATCATCA TGTCTCGTAA AGCTCCATGC AAATATGAAG TACGGGGCAA  GTGCAACAGG GGAAGTGAGT GCAAATTCAA CCACAATTAC TGGAGTTGGC 4800
4801 CTGATAGGTA TTTATTGTTA AGATCAAATT ATCTCTTGAA TCAGCTTTTA  AGAAACACTG ATAAGGCTGA TGGTTTGTCA ATAATATCAG GAGCAGGTAG 4900
4901 AGAAGACAGG ACTCAAGACT TTGTTCTTGG TTCTACTAAT GTGGTTCAAG  GGTACATTGA TGACAATCAA GGAATAACAA AGGCTGCAGC TTGCTATAGT 5000
5001 CTACATAACA TAATAAAACA GCTACAAGAA ATAGAAGTAA GACAGGCCAG  AGATAATAAG CTTTCTGACA GCAAACATGT GGCACTTCAC AACTTGATAT 5100
5101 TATCCTATAT GGAGATGAGC AAAACTCCTG CATCCCTGAT TAATAACCTA  AAGAAACTAC CAAGAGAAAA ACTGAAAAAA TTAGCGAAAT TAATAATTGA 5200
5201 TTTATCAGCA GGAACTGATA ATGACTCTTC ATATGCCTTG CAAGACAGTG  AAAGCACTAA TCAAGTGCAG TAAGCATGGT CCCAAATTCA TCACCATAGA 5300
5301 GGCAGATGAT ATGATATGGA CACACAAAGA ATTAAAAGAG ACACTGTCTG  ATGGGATAGC AAAATCACAC ACCAATATTT ACAGTTGTTA TTTAGAAAAT 5400
5401 ATAGAAATAA TATATGTTAA AGCTTACTTA AGTTAGTAAA AAATAAATAG  AATGGGATAA ATGACAATGA AAACATTAGA TGTCATAAAA AGTGACGGAT 5500
5501 CCTCAGAAAC ATGTAATCAA CTCAAAAAAA TAATAAAAAA ACACTCAGGT  AAATTGCTTA TTGCATCAAA ACCGACATTG GCCTTATTGA CGTCCTTCAC 5600
5601 AGTAACAATT ACTGTCAACT ATACAAAAGT AGAAAATAAT TTGCAGGCAT  GTCAATTAAA AAATGAATCA GACAAAAAGG ACACAAAGCT AAATACCACA 5700
5701 TCAACAACAA TCAGACCCAT TCCTGATCTA AATGCAGTAC AGTACCTGAA  AAGGCTGATT CAGAAACACA CCAACTCTGT CACAAAAGAC AGAGATACCT 5800
5801 GTTGGAGAAT ACACACGAAT CAATGCACAA ATATAAAAAT ATATAAGTTC  TTATGTTTTG GGTCTATGAA TTCAACAAAT ACAGACTGTG AAGAACCAAC 5900
5901 AGTTCTATGC GACAAAAAGT CAAAAACCAT GACAGAAAAA CATAGGAAAG  CAGAGTGTCA CCGTCCACAT ACAACCGAGT GGTGGTGCCA TTATCTTTAA 6000
6001 GAGAAAACTC AGTTTTCAAC ATTAAAATCA GAACAAATCA TATCTAGATC  TATTAATATA ATAGTCTAGT TATTTAAAAA CTCTAAATAT TGTCTAGACT 6100
6101 TCACAACACC CTGCGGTCAT ATGCAATAAT CAATGGTCAA ACCACTGTTG  CAAACCCACC TATAATACAA TCACTGAGTA ATACAAAACA AGAAAATGGG 6200
6201 ACAAGTGGCC ATGGAAGCAA GAGTGGAGAA CATTCGGGCA ATAGACATGT  TCAAAGCAAA GATGAAAAAC CGTATAAGAA GTAGCAAGTG CCATAGAAAT 6300
6301 GCTACACTGA TCCTTATTGG ATCAACAGCA CCAAGTATGG CACTCAACAC  CCTTTTAATC ATTGATCATG CAACATCAAA AAACATGACC AAAGTGGAAC 6400
6401 ACTGTGTCAA CATGCCGCCG GTAGAACCAA GCAAGAAGAC CCCAATGACC  TCTGCAGCAG ACCCAAACAC CAAACCCAAT CCACAGCAGG CAACACAGCT 6500
6501 GACCACAGAG GATTCAACAT CTCTAGCAGC AACCCTAGAG GACCATCTAC  ACACAGGGAC AACTCCAACA CCAGATGCAA CAGTCTCCCA GCAAACCACA 6600
6601 GACGAGCACA CAACACTGCT GAGATCAACC AACAGACAGA CCACCCAAAC  AACCGCAGAG AAAAAGCCAA CCAGAGCAAC AACCAAAAAA GAAACCACAA 6700
6701 CTCGAACCAC AAGCACAGCT GCAACCCAAA CACTCAACAC CACCAACCAA  ACTAGCAATG GAAGAGAGGC AACCACAACA TCTGCCAGAT CCAGAAACAA 6800
6801 TGCCACAACT CAAAGCAGCG ATCAAACAAC CCAGGCAGCA GACCCAAGCT  CCCAATCACA ACATACACAG AAAAGCACAA CAACAACACA CAACACAGAC 6900
6901 ACATCTTCTC CAAGTAGTTA ACAAAAAAAC TATAAAATAA CCATGAAAAC  CAAAAAACTA GAAAAGTTAA TTTGAACTCA GAAAAGAACA CAAACACTAT 7000
7001 ATGAATTGTT TGAGCGTATA TACTAATGAA ATAGCATCTG TTTGTGCATC  AATAATACCA TCATTATTTA AGAAATAAGA AGAAGCTAAA ATTCAAGGGA 7100
7101 CAAATAACAA TGGATCCGTT TTGTGAATCC ACTGTCAATG TCTATCTTCC  TGATTCATAT CTCAAAGGAG TAATATCTTT CAGTGAAACC AATGCAATTG 7200
7201 GCTCATGCCT TTTGAAAAGA CCCTATCTTA AAAAAGATAA CACTGCTAAA  GTTGCTGTAG AAAACCCTGT TGTTGAACAT GTCAGACTTA GAAATGCAGT 7300
7301 CATGACCAAA ATGAAGATAT CAGATTATAA AGTGGTTGAA CCAATTAATA  TGCAGCATGA AATAATGAAA AATATACACA GTTGTGAGCT CACATTATTA 7400
7401 AAACAATTCT TAACAAGAAG TAAAAACATT AGCTCCCTAA AATTAAGTAT  GATATGTGAT TGGTTACAGT TAAAATCCAC CTCAGATAAC ACATCAATTC 7500
7501 TTAATTTTAT AGATGTGGAG TTTATACCCG TTTGGGTGAG CAATTGGTTT  AGTAACTGGT ATAATCTCAA TAAATTAATC TTAGAGTTTA GAAGAGAGGA 7600
7601 AGTAATAAGA ACTGGTTCAA TTTTATGCAG ATCACTAGGC AAGTTAGTTT  TCATTGTATC ATCTTATGGG TGTGTAGTAA AAAGCAACAA AAGTAAAAGA 7700
7701 GTAAGTTTTT TCACATATAA CCAACTGTTA ACATGGAAAG ATGTGATGTT  AAGTAGGTTC AATGCAAACT TTTGTATATG GGTAAGTAAC AACCTGAACA 7800
```

Fig. 39B

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 64 of 66 Sheets

HMPV strain 75 (continued)

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 7801 AAAATCAAGA AGGACTAGGA TTTAGAAGTA ATCTACAAGG TATGTTAACT  AATAAATTAT ATGAAACTGT TGATTATATG TTAAGTCTAT GTAGCAATGA 7900
 7901 AGGGTTCTCA CTAGTGAAAG AGTTCGAAGG CTTTATTATG AGTGAAATTC  TTAAAATTAC TGAGCATGCT CAATTCAGTA CTAGGTTTAG GAATACTTTA 8000
 8001 TTAAATGGGT TGACTGAACA ATTATCAATG TTGAAAGCTA AAAACAGATC  TAGAGTTCTT GGCACTATAT TAGAAAACAA TGATTACCCC ATGTATGAAG 8100
 8101 TAGTACTTAA ATTATTAGGG GACACTTTGA AAAGTATAAA ATTATTAATT  AACAAGAATT TAGAAAATGC TGCAGAATTA TATTATATAT TCAGAATTTT 8200
 8201 TGGACACCCT ATGGTAGATG AGAGGGAAGC AATGGATGCT GTTAAATTAA  ATAATGAGAT TACAAAAATT CTTAAACTGG AGAGCTTAAC AGAACTAAGA 8300
 8301 GGAGCATTTA TACTAAGAAT TATAAAAGGG TTTGTAGATA ATAATAAAAG  ATGGCCTAAA ATTAAGAATT TAAAAGTGCT CAGTAAAAGA TGGGTTATGT 8400
 8401 ATTTCAAAGC TAAAAGTTAC CCTAGCCAAC TTGAGCTAAG TGTACAAGAT  TTTTTAGAAC TTGCTGCAGT ACAATTCGAA CAGGAATTTT CTGTCCCTGA 8500
 8501 AAAAACCAAT CTTGAGATGG TATTAAATGA TAAAGCAATA TCTCCACCAA  AAAAGTTAAT ATGGTCGGTA TATCCAAAAA ATTATCTACC TGAAATTATA 8600
 8601 AAAAATCAAT ATTTAGAAGA GGTCTTCAAT GCAAGTGACA GTCAAAGAAC  GAGGAGAGTC TTAGAATTTT ACTTAAAAGA TTGCAAATTT GATCAAAAAG 8700
 8701 ACCTCAAACG TTATGTAACT AAACAAGAGT ATCTAAATGA CAAAGACCAC  ATTGTCTCAT TAACTGGGAA AGAAAGAGAA TTAAGTGTAG GCAGGATGTT 8800
 8801 TGCAATGCAA CCTGGCAAAC AAAGACAAAT ACAGATACTA GCCGAGAAAC  TTTTAGCTGA TAATATTGTA CCCTTTTTCC CAGAAACTTT AACAAAGTAT 8900
 8901 GGTGACTTGG ATCTCCAAAG AATTATGGAA ATGAAATCAG AACTTTCTTC  CATTAAAACT AGGAAGAATG ATAGTTACAA CAATTATATT GCAAGAGCCT 9000
 9001 CCATAGTAAC AGACCTAAGT AAATTCAATC AAGCCTTTAG ATATGAAACC  ACAGCTATCT GCGCAGACGT AGCAGATGAG TTACATGGCA CGCAAAGCTT 9100
 9101 ATTTTGTTGG TTACATCTTA TTGTTCCCAT GACCACAATG ATATGTGCAT  ACAGACATGC ACCACCAGAA ACAAAGGGGG AGTATGATAT AGACAAAATA 9200
 9201 GAAGAGCAAA GTGGGCTATA CAGATACCAT ATGGGAGGGA TTGAAGGGTG  GTGTCAGAAG TTATGGACAA TGGAGGCGAT ATCCTTGTTA GATGTAGTAT 9300
 9301 CTGTTAAGAC TCGTTGTCAG ATGACCTCTC TATTAAACGG AGACAATCAA  TCAATAGATG TCAGTAAACC AGTAAAATTG TCTGAAGGTA TAGATGAAGT 9400
 9401 AAAAGCAGAT TATAGCTTAG CAATTAAAAT GCTTAAAGAG ATAAGAGATG  CCTATAAAAA CATTGGCCAT AAACTCAAAG AAGGTGAAAC ATATATATCA 9500
 9501 AGAGATCTTC AATTTATAAG TAAGGTGATT CAATCTGAGG GGGTCATGCA  TCCTACCCCC ATAAAAAAGA TATTAAGGGT AGGTCCCTGG ATAAATACAA 9600
 9601 TACTAGATGA CATTAAAACT AGTGCAGAAT CAATAGGGAG TCTGTGTCAA  GAACTAGAGT TCAGAGGAGA AAGTATACTA GTTAGCTTGA TATTAAGGAA 9700
 9701 TTTCTGGCTG TATAACTTAT ACATGCATGA GTCAAAACAG CATCCGTTAG  CTGGAAAACA ACTGTTTAAA CAATTGAACA AAACACTAAC ATCTGTGCAA 9800
 9801 AGATTTTTTG AGCTGAAGAA AGAAAATGAT GTGGTTGACC TATGGATGAA  TATACCAATG CAGTTTGGAG GGGGAGACCC AGTAGTTTTT TACAGATCTT 9900
 9901 TTTACAGAAG GACTCCTGAT TTCTTGACTG AAGCAATCAG CCATGTGGAT  TTACTGTTAA AAGTTTCAAA CAATATTAAA AATGAGACTA AGATACGATT 10000
10001 CTTTAAAGCC TTATTATCTA TAGAAAAGAA TGAACGTGCT ACATTAACAA  CACTAATGAG AGACCCCCAG GCGGTAGGAT CGGAAAGACA AGCTAAGGTA 10100
10101 ACAAGTGATA TAAATAGAAC AGCAGTTACT AGCATACTGA GTCTATCTCC  GAATCAGCTA TTTTGTGATA GTGCTATACA CTATAGCAGA AATGAAGAAG 10200
10201 AAGTAGGGAT CATTGCAGAC AACATAACAC CTGTTTATCC TCACGGATTG  AGAGTGCTCT ATGAATCACT ACCTTTTCAT AAGGCTGAAA AGGTTGTCAA 10300
10301 TATGATATCA GGTACAAAGT CTATAACTAA CCTATTGCAG AGAACATCTG  CTATCAATGG TGAAGATATT GATAGAGCAG TGTCTATGAT GTTAGAGAAC 10400
10401 TTAGGGTTGT TATCTAGGAT ATTGTCAGTA ATAATTAATA GTATAGAAAT  ACCAATTAAG TCCAATGGCA GATTGATATG CTGTCAAATT TCTAAGACTT 10500
10501 TGAGAGAAAA ATCATGGAAC AATATGGAAA TAGTAGGAGT GACATCTCCA  AGTATTGTAA CATGTATGGA TGTTGTGTAT GCGACTAGTT CTCATTTAAA 10600
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10701 GTTCCTGTTT ATAACAGACA AATTCTTTCA AAACAACAAA AAGAGCAACT  GGAAGCAATA GGAAAAATGA GGTGGGTGTA TAAAGGAACT CCAGGGCTAA 10800
10801 GAAGATTGCT CAATAAGATT TGCATAGGAA GTTTAGGTAT TAGCTATAAA  TGTGTAAAAC CTCTATTACC AAGATTTATG AGTGTAAACT TCTTACATAG 10900
10901 GTTATCTGTT AGTAGCAGAC CCATGGAATT CCCAGCTTCT GTTCCAGCTT  ATAGGACAAC AAATTACCAC TTTGACACTA GTCCAATCAA CCAAGCATTA 11000
11001 AGTGAGAGGT TCGGGAACGA AGACATTAAT CTAGTGTTCC AAAATGCAAT  CAGCTGCGGA ATTAGTATAA TGAGTGTTGT AGAACAGTTA ACTGGTAGAA 11100
11101 GCCCAAAACA ATTAGTCTTA ATCCCCCAAT TAGAAGAGAT AGATATTATG  CCCCCTCCTG TATTTCAAGG AAAATTCAAT TATAAACTAG TTGATAAAAT 11200
11201 AACCTCCGAT CAACACATCT TCAGTCCTGA CAAAATAGAC ATATTAACAC  TAGGGAAGAT GCTTATGCCT ACTATAAAAG GTCAAAAAAC TGATCAGTTC 11300
11301 TTAAATAAGA GAGAAAACTA TTTCCATGGA AATAATTTAA TTGAATCTTT  ATCTGCAGCA CTTGCATGCC ATTGGTGTGG AATATTAACA GAACAGTGTG 11400
11401 TAGAAAACAA TATCTTTAGG AAAGACTGGG GTGATGGGTT CATATCAGAT  CATGCCTTCA TGGATTTCAA GATATTTCTA TGTGTATTTA AAACCAAACT 11500
11501 TTTATGTAGT TGGGGATCCC AAGGGAAAAA TGTAAAAGAT GAAGATATAA  TAGATGAATC CATTGACAAA TTATTAAGAA TTGACAACAC TTTTTGGAGA 11600
11601 ATGTTCAGCA AAGTCATGTT TGAATCAAAG GTCAAAAAAA GAATAATGTT  ATATGATGTA AAATTCCTAT CATTAGTAGG TTATATAGGA TTTAAAAACT 11700
11701 GGTTTATAGA GCAGTTAAGA GTAGTAGAAT TGCATGAAGT ACCCTGGATT  GTCAATGCTG AAGGGGAGCT AGTTGAAATT AAACCAATCA AAATTTATTT 11800
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Fig. 39C

Attorney Ref. No. 4239-67784
Inventors: Peter L. Collins, Stephane Biacchesi, Ursula Buchholz, Brian R. Murphy, and Mario H. Skiadopoulos
Title: RECOMBINANT HUMAN METAPNEUMOVIRUS AND ITS USE
Express Mail No. EV331582468US
DRAWINGS: Sheet 65 of 66 Sheets

HMPV strain 75 (continued)

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11801 GCAGTTAATA GAACAAAGTC TATCTTTAAG AATAACTGTT TTGAATTATA  CAGACATGGC ACATGCTCTT ACACGATTAA TTAGGAAGAA ATTGATGTGT 11900
11901 GATAATGCAC TCTTTAATCC AAGTTCATCA CCAATGTTTA GTCTAACTCA  AGTTATTGAT CCTACAACAC AGCTAGACTA TTTTCCTAAG GTAATATTTG 12000
12001 AAAGGTTAAA AAGTTATGAC ACCAGTTCAG ACTACAACAA AGGGAAGTTA  ACAAGAAATT ACATGACATT ATTACCATGG CAGCACGTAA ACAGGTATAA 12100
12101 TTTTGTCTTT AGTTCAACAG GATGTAAAAT CAGCTTGAAG ACATGCATCG  GGAAATTGAT AAAGGACTTA AACCCTAAGG TTCTTTACTT TATTGGAGAA 12200
12201 GGAGCAGGTA ACTGGATGGC AAGAACAGCA TGTGAGTATC CTGACATAAA  ATTTGTATAT AGGAGTTTAA AGGATGATCT TGATCACCAT TACCCATTAG 12300
12301 AATATCAAAG GGTAATAGGT GATTTAAATA GAGTAATAGA TGGTGGTGAA  GGATTATCAA TGGAGACCAC AGATGCAACT CAAAAGACTC ATTGGGACTT 12400
12401 GATACACAGA ATAAGTAAAG ATGCTTTATT GATAACATTG TGTGATGCAG  AATTCAAAAA CAGAGATGAT TTCTTTAAAA TGGTAATTCT TTGGAGAAAA 12500
12501 CATGTATTAT CATGTAGAAT CTGTACAGCT TATGGAACAG ATCTTTACTT  ATTTGCAAAG TATCATGCGA CGGACTGCAA TATAAAGTTA CCATTTTTTG 12600
12601 TAAGGTCTGT AGCTACTTTT ATTATGCAAG GAAGCAAATT GTCAGGATCA  GAATGTTACA TACTTTTAAC ATTAGGTCAT CACAATAATC TGCCATGTCA 12700
12701 CGGAGAAATA CAAAATTCCA AAATGAGAAT AGCAGTGTGT AATGATTTCC  ATGCCTCAAA AAAACTAGAC AACAAATCAA TTGAAGCAAA CTGCAAATCT 12800
12801 CTTCTATCAG GATTAAGAAT ACCAATAAAC AAAAAAGAGT TAAATAGACA  AAAGAAACTG TTAACACTAC AAAGCAATCA TTCTTCCATA GCAACAGTTG 12900
12901 GCGGAAGTAA GATTATAGAA TCCAAATGGT TAAAGAATAA AGCAAGTACA  ATAATTGATT GGTTAGAGCA TATCTTGAAT TCTCCAAGAG GTGAATTAAA 13000
13001 CTATGATTTC TTTGAAGCAT TAGAGAACAC ATATCCCAAT ATGATCAAGC  TTATAGATAA CCTGGGAAAT GCAGAGATAA AAAAACTAAT CAAAGTTACC 13100
13101 GGGTATATGC TTGTGAGTGA GAAGTAATAA TAATAATAAT AATCAACCAT  AATCTCACAC AACTGAGAAA ATGATCATCT AACAGTTTAA TTGACCATTA 13200
13201 GTTAATTAAA AATTATAAAT TAGTAACTAA TTGATAAAAA ATAAGAAATT  GAAATTGAAT GTATACGGTT TTTTTGCCGT                       13280
          |   10      |   20      |   30      |   40      |   50      |   60      |   70      |   80      |   90      |  100
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Fig. 39D